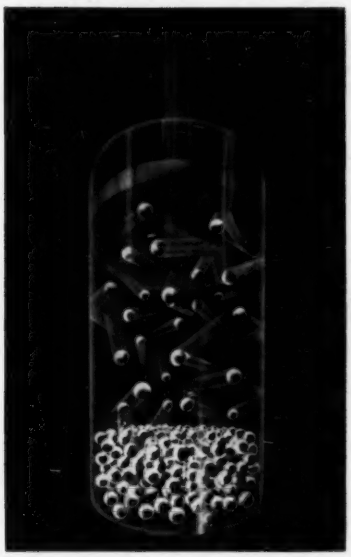
GENERATION, TRANS[illegible]ND APPLICATION OF THE POWER SERVICES • A McGRAW-HILL PUBLICATION

Power

AUGUST 1956•50¢



THERMO REFRESHER: An easy-to-grasp heat-power series keyed to growing power field needs. . p 98

PUMP-TURBINE at TVA's Hiwassee Dam is world's largest: about 60 mw as generator, 100,000 hp when running as pump. . . . . p 79

There's **MORE** rating selection available in Allis-Chalmers **MOTORS**

To meet power plant needs . . .

Allis-Chalmers Offers Complete Line of Rib-Type MOTORS from 1 to 100 Hp

Allis-Chalmers, a pioneer in rib-type TEFC motor design, is the only leading manufacturer offering a complete line of these motors from 1 to 100 hp. The many cost-saving features of deep-rib construction can be applied in a variety of uses . . . both indoors and out.

Here's why these motors can cut power costs:

MORE cooling surface — Rib-type design provides reserve cooling capacity in dirty locations.

MORE iron—Cast-iron frame and external parts assure rigidity and resistance to corrosion.

MORE copper — Allis-Chalmers greater use of copper increases electrical life.

MORE lubrication provisions — Large grease reservoirs surround bearings. Provision made for in-service relubrication — important where moisture or corrosive vapors contaminate grease.

As a new machinery component or as replacement, specify Allis-Chalmers. To find out more, contact your nearby Allis-Chalmers distributor, district office, or write Allis-Chalmers, General Products Division Milwaukee 1, Wisconsin.

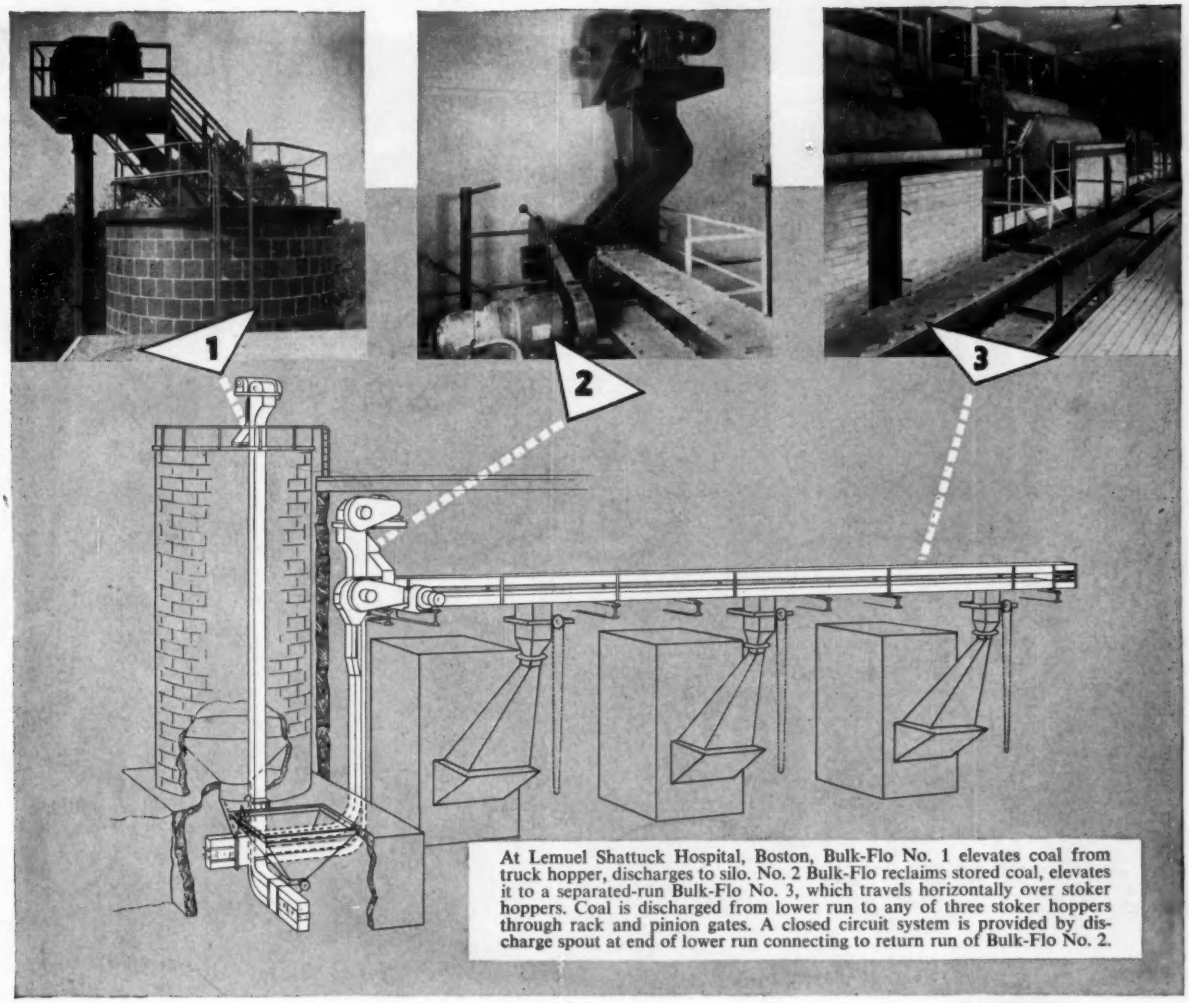
A-4948

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Elevating...Feeding...Conveying

LINK-BELT Bulk-Flo chosen for all 3 basic coal handling functions



At Lemuel Shattuck Hospital, Boston, Bulk-Flo No. 1 elevates coal from truck hopper, discharges to silo. No. 2 Bulk-Flo reclaims stored coal, elevates it to a separated-run Bulk-Flo No. 3, which travels horizontally over stoker hoppers. Coal is discharged from lower run to any of three stoker hoppers through rack and pinion gates. A closed circuit system is provided by discharge spout at end of lower run connecting to return run of Bulk-Flo No. 2.

In this installation Bulk-Flo handles the coal all the way—from truck hopper, to and from storage silo, to any of three stoker hoppers. Compactness of Bulk-Flo plus its ability to convey and elevate in a single unit made it ideal for this application.

Versatile Bulk-Flo consists of an endless strand of chain to which solid flights are bolted, operating in a close-fitting, dust-tight casing. Design permits efficient operation whether flights are fully or partially loaded.

Link-Belt's line of coal handling equipment is complete—see list at right. Our engineers have experience gained through hundreds of successful installations. They'll work with your engineers or consultants . . . give you lower cost per ton of coal handled.

Whether your plant is large or small, bring your coal handling needs to Link-Belt. Call your nearest Link-Belt office for full information and a copy of Bulk-Flo Book 2475 or Book 2410, containing 44 pages of typical power plant equipment and layouts.

LINK-BELT power plant equipment includes:

Belt, screw, Bulk-Flo, apron and flight conveyors; bucket carriers, bucket elevators, skip hoists, car shakers and dumpers, weigh larries, coal crushers and a complete line of chains and mechanical power transmission machinery.

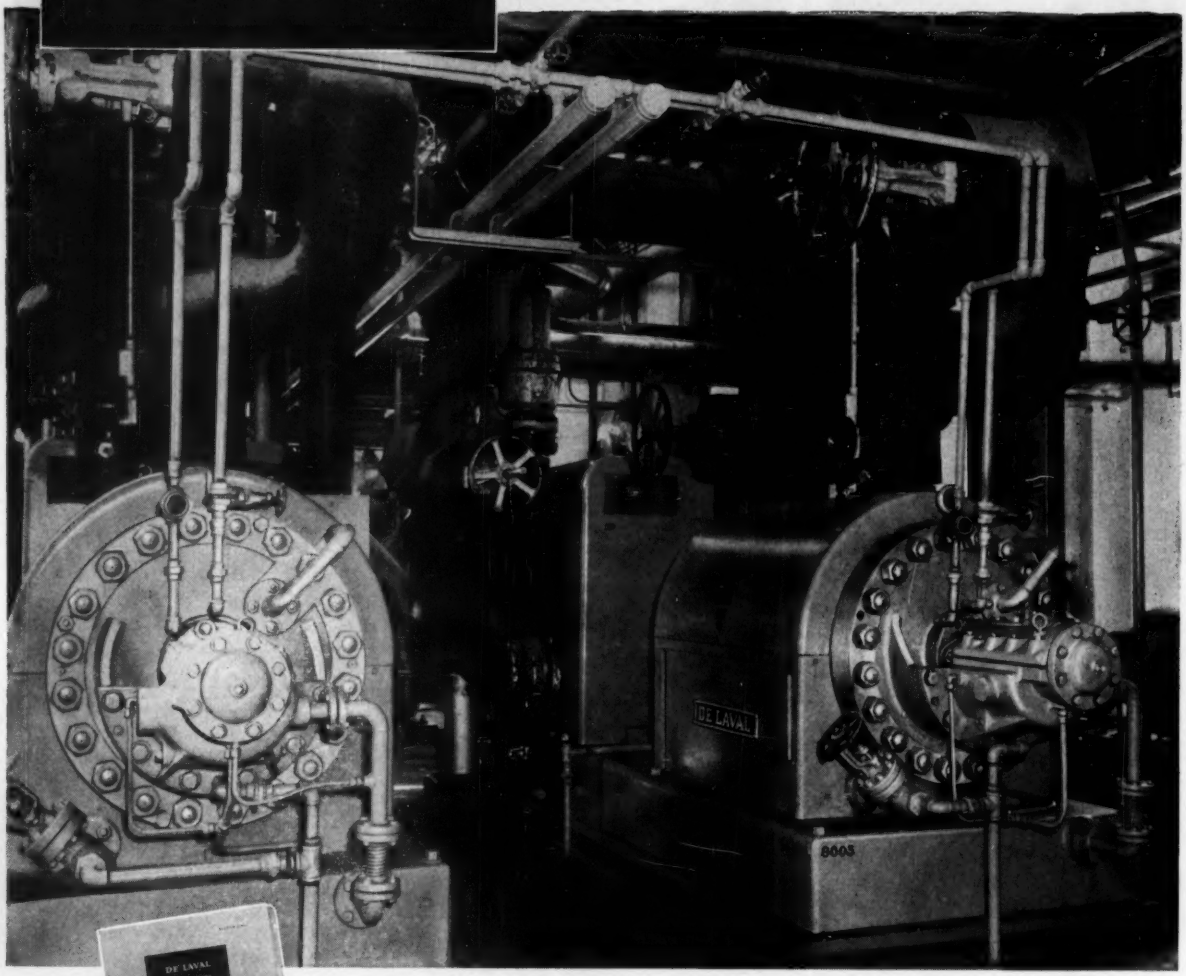
LINK-BELT

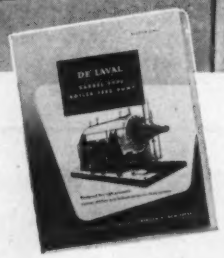
COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,008

DE LAVAL
BARREL TYPE BOILER FEED PUMPS

give dependable service at Gaylord Container





Bulletin contains helpful data

Bulletin 1506 on the De Laval barrel type boiler feed pump covers all major design points... has cross-section cutaway illustration for easy reference. Write for your copy.

Here's additional proof of De Laval reliability on the line in the Bogalusa, La. plant of the Gaylord Container Corporation. These two De Laval barrel type boiler feed pumps are both driven by De Laval MCP turbines operating at 850 psi, with steam temperature at 825 F.

• De Laval barrel type boiler feed pumps are widely used by industrial plants and public utilities. They operate at pressures up to 5,500 psi. These units offer many important design advantages, such as double volute diaphragm, individual diaphragm bolting, positive sealing between suction and discharge chamber and bare shaft construction. Their dependability is proven by year-in, year-out service.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

DL 938

Power

AUGUST 1956 • VOLUME 100 NUMBER 8

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Print order this issue: 48,433

WORLD'S LARGEST PUMP-TURBINE, on cover photo, is Unit 2 at TVA's Hiwassee Dam. Turbine diameter at center line of distributor measures 266 in. In full operation since May, Unit 2 offers as its chief value the peaking capacity it can add during critical load periods. Article on p 79 contains full dope, summarizes developments of other large pump-turbine units.

Next month . . .

Maintenance control gets a modern twist from a punch-card system that selects machinery to be checked at set periods. Coming article tells how method ends motor burnouts, bearing failures, other faults by pointing out machines needing maintenance.

Boiler-wall repair faced by Carbide & Carbon Chemical Co called for sharp thinking, engineering savvy. Problem was to repair a 7-ft section without taking boiler off the line. One of the most unusual wall repairs ever attempted . . . and accomplished, it's detailed in a fast-reading 2-pager.

Power to grow—electrically program gets a September kickoff. The year-long series will deal with each part of the in-plant electrical system—showing today's best practice and how to apply that practice to meet tomorrow's growing demands. Don't miss it.

. . . and future months

Modern Plant Yearbook Issue is all set for mid-September. Among high spots are the Modern Plant Survey and announcement of plants receiving citations in POWER's Modernization Awards program. Watch for your copy!

AUGUST 1956 POWER Vol. 100—No. 8

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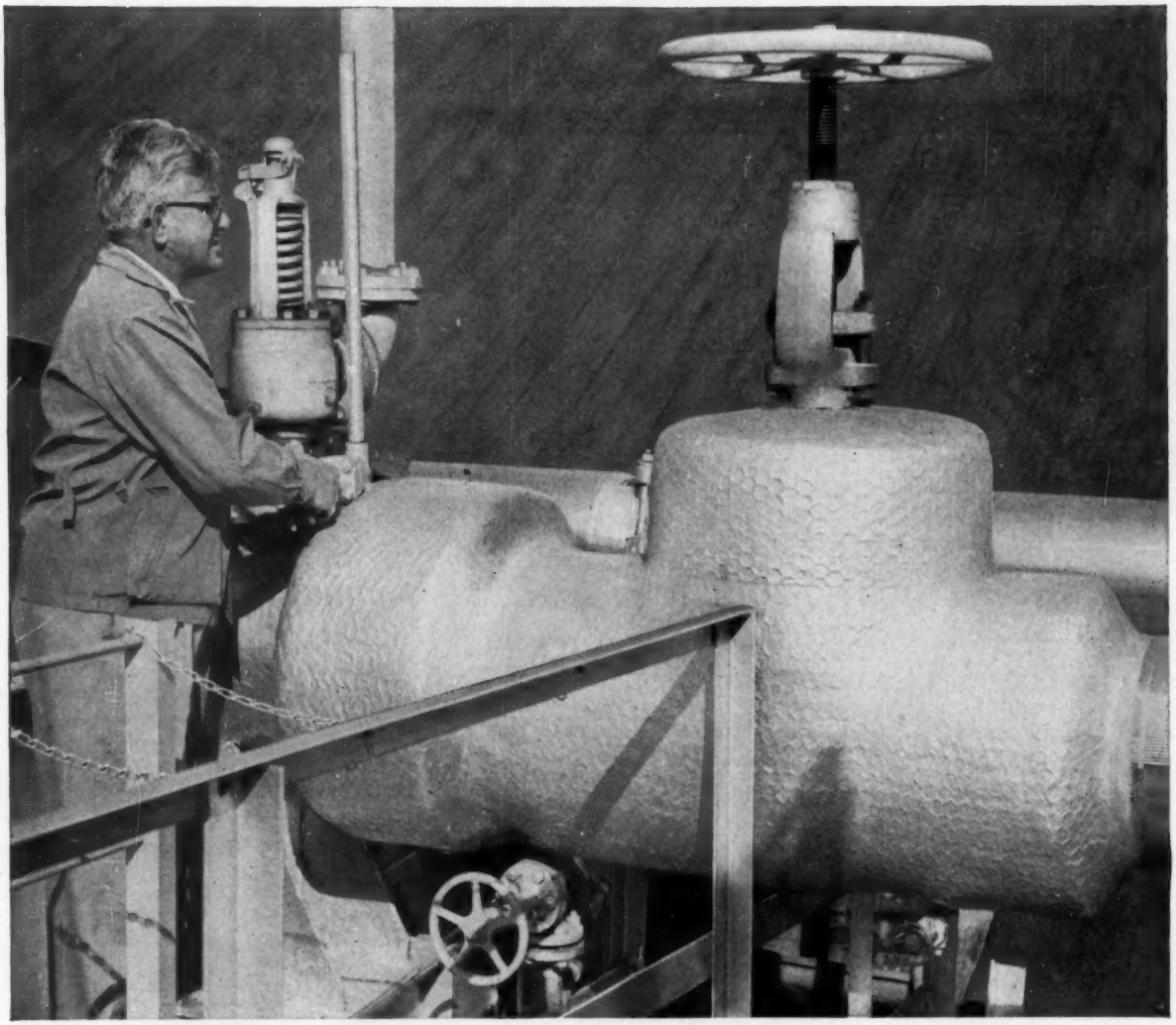


This Crane valve has 20-year cost-free record on 400 psi. steam at 750° F.

Twenty years on this high-temperature steam boiler outlet service with never a wrench on it—that's valve performance in any man's language.

This Crane 8-inch No. 179U cast steel stop-check valve has racked up just such a record at Fort Bend Utilities Co., Sugar Land, Texas, and is working as smoothly today as it did two decades ago.

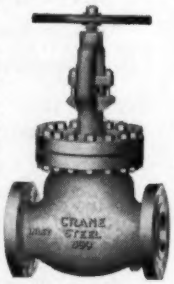
The Fort Bend Utilities plant—a subsidiary of the neighboring Imperial Sugar Co.—finds this Crane stop-check an important aid to boiler efficiency.

Its high-lift disc permits maximum flow-through, with minimum pressure drop under varying load conditions. Seating is instantaneous on back flow.

On manual closure, about once yearly for boiler servicing, the valve has never failed to respond smoothly and seat tightly.

To valve users experienced with Crane quality, this performance record is not so unusual. Thousands of Crane stop-checks throughout industry are giving similarly outstanding service.

The superior materials, the top-flight engineering and construction designed into all Crane valves give them service capacity and durability second to none.



Get these advantages next time you order valves: specify Crane and be *certain* of the valve service you want. Consult your local Crane Representative or write to address below.

CRANE VALVES & FITTINGS

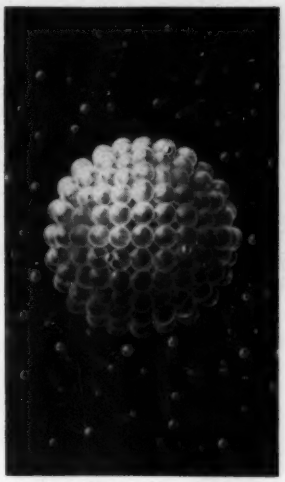
PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

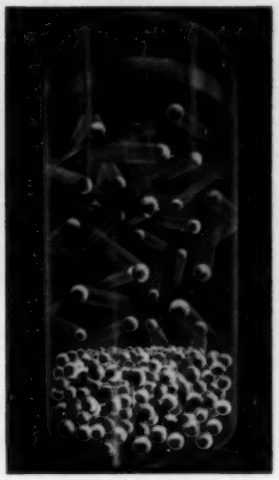
speaking of **Power**

New *Thermo Refresher* series: mental tune-up for big power years ahead

Beads were nucleons when Ben Skrotzki guided series on . . .



Nuclear Energy. Now he's . . .



probing field of heat power

Sitting quietly at his desk a few months ago, Associate Editor Ben Skrotzki started arranging a mass of white and colored plastic beads into an orderly compact form. Beads were the fit-together type, called pop beads by today's female teen-agers. But, as you might well expect, Ben's mind was far from simple bead assembly: He was empirically solving, for his own satisfaction, a complex nucleus-arrangement problem while editing one of the series in the now completed *Nuclear Energy Study Course*. Today Ben is absorbed in a somewhat different area of mental gymnastics, tying in with his new *Thermo Refresher*, starting on page 98 in this issue.

Why this series, at this time? For the answer, look at power growth today, as you weigh its predicted future. And since power growth and technical complexity generally march hand in hand, the power man sees his operating sphere growing more complex while enlarging.

Even a casual analysis of the power services shows the science of thermodynamics playing a major role in all, with the possible exception of electricity. So whether your present concern is combustion or air conditioning, compressed air or pumping, you'll find this series of significant help. And that holds equally for the seasoned engineer and the technical neophyte. To the former, *Thermo Refresher* will be a true refresher; to the latter, an easily comprehended study course.

Two approaches may be used in publishing a technical series: Select a recognized authority in the field as author, or have a staff editor write as well as edit the complete series. We chose the former in the just-completed *Nuclear Energy Study Course*. In this latest series, *Thermo Refresher*, staffer Ben Skrotzki elected to do the complete job. He is eminently qualified, having taught engineering thermodynamics for many years at Cooper Union, authored and edited six recognized texts in the power field. We know you'll benefit from this new series while gearing up for the big power years that lie ahead.

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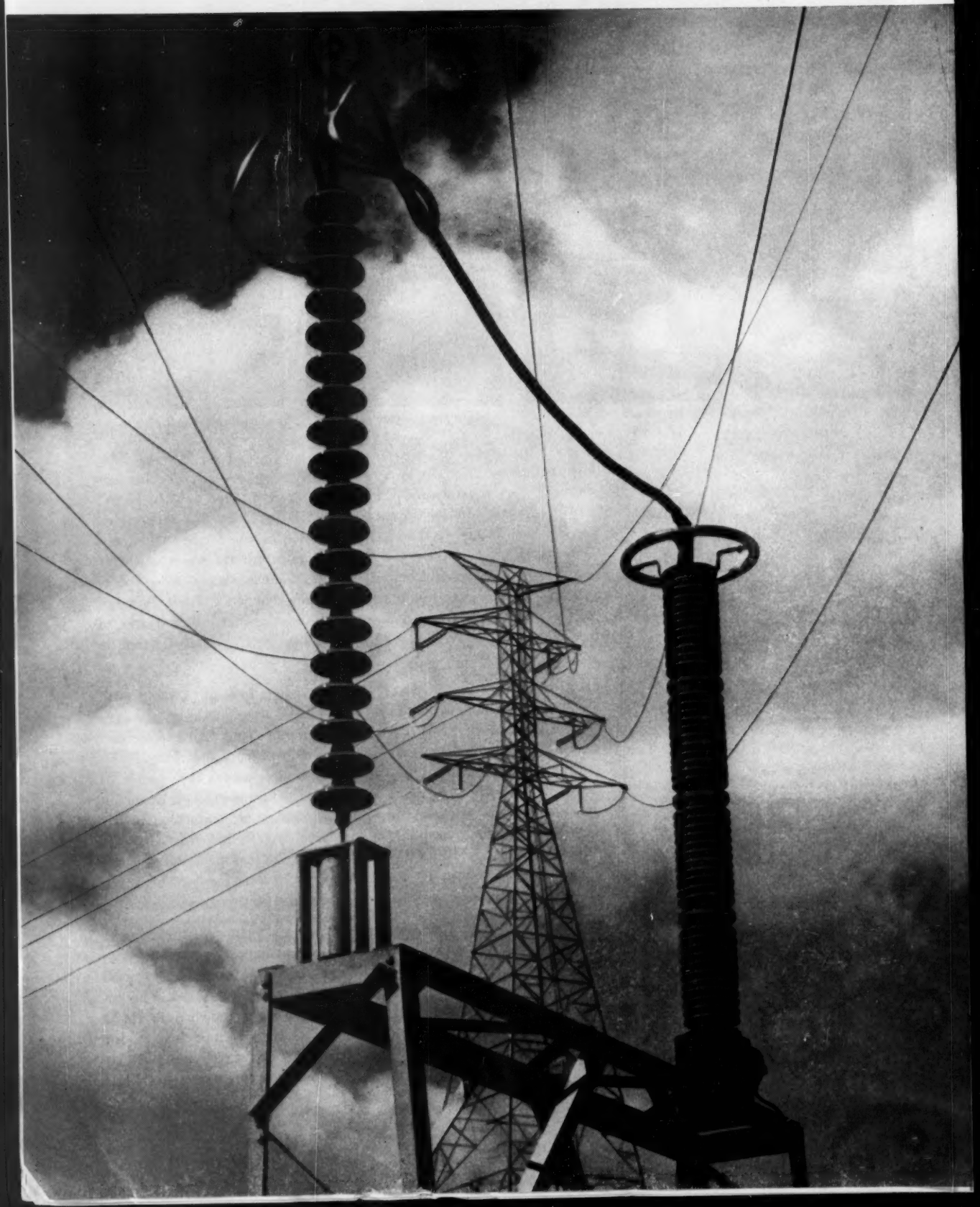
For the Mass



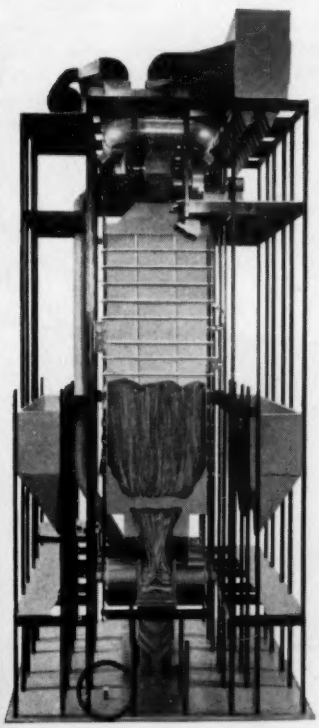
Production of Energy

"AMERICAN GAS AND ELECTRIC SYSTEM looks for a higher level of efficiency in the production of electric power than has ever been achieved before."

This firm prediction by Philip Sporn, president of the American Gas and Electric System, refers to the two largest steam-electric generating units in the world, which are to be added to the facilities of AGE.

Second and Third Universal Pressure Units for AGE

Each unit will produce 450,000 kw, enough power to supply the residential need for a city of 4,000,000 people—*more electricity than many complete utility systems.* Steam generators for the two units are of the B&W Universal Pressure type, and will be the second and third to go into commercial service. The first will start producing power at Ohio Power's Philo Plant in the near future.



Cyclone Furnace-fired B&W Universal Pressure Steam Generator to serve 450 MW turbine. Design pressure 4500 psi. Generates 2,900,000 pounds of steam per hour at 3625 psi, 1050 F. There are two stages of reheat to 1050 F. The second unit is similar in design but will be pulverized-coal-fired. Note comparison with six foot man standing at basement level.

Coal the Main Energy Source for Years Ahead

The decision to go ahead with these super-pressure, coal-fired units is based upon the fact that the bulk of our energy, for many years ahead, will come from coal, burned efficiently with economical equipment.

Two Firing Methods Utilized

Each of the B&W Universal Pressure Units will generate 2,900,000 lb of steam per hour. One will be Cyclone Furnace-fired and the other pulverized-coal-fired, to take greatest advantage of the method better suited to fuel and operating conditions in each case.

It takes courage and confidence in their engineering ability for AGE to initiate these world's largest generating units—and this confidence is reinforced by the work of the B&W organization and by previous experience with B&W research, engineering, manufacturing, field development and erection. These capabilities, skills and facilities are the real resources of B&W. For nearly 100 years they have been dedicated to serving the current and future steam-electric power needs of the nation.

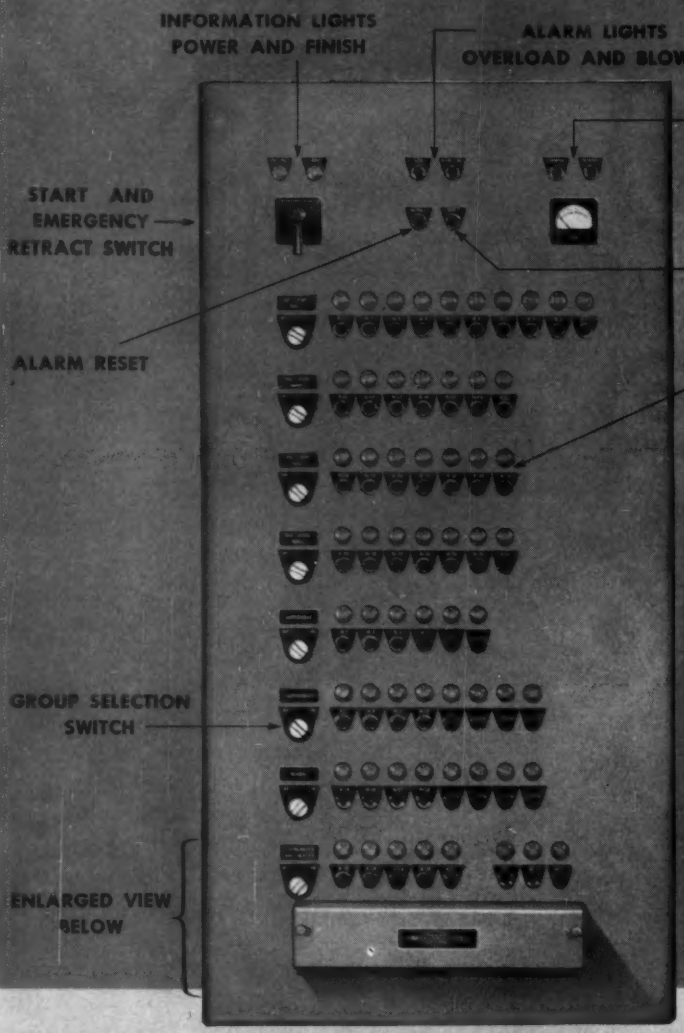
The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N.Y.

BABCOCK & WILCOX

BOILER DIVISION

G-81

A New Concept in Boiler Cleaning



SELECTROMATIC PANEL WITH "VARIABLE-GROUP" CONTROL

Note complete operating information and protection provided at top of panel. To start complete cleaning cycle, operator simply turns switch handle (he can immediately retract any blower during operation by turning handle in other direction); when programmed cleaning cycle is completed, shut-off is automatic. Each blower has an indicating light and a three-position switch: (1) automatic operation, (2) bypass, and (3) manual operation. Each group has a two- or a three-position switch: (1) automatic operation, (2) bypass, and (3) repeat operation (when desired). Group selection box at bottom permits any desired sequence of group operation by proper arrangement of plugs and jacks. Complete flexibility of cleaning control is provided.

Selectromatic panels are also available without "Variable-Group" features so that blower groups always clean (or are bypassed) in same sequence. Still another modification omits group control entirely.

7348

DIAMOND POWER SPECIALTY

. ."GROUP CONTROL" with

Diamond

SELECTROMATIC* PANELS

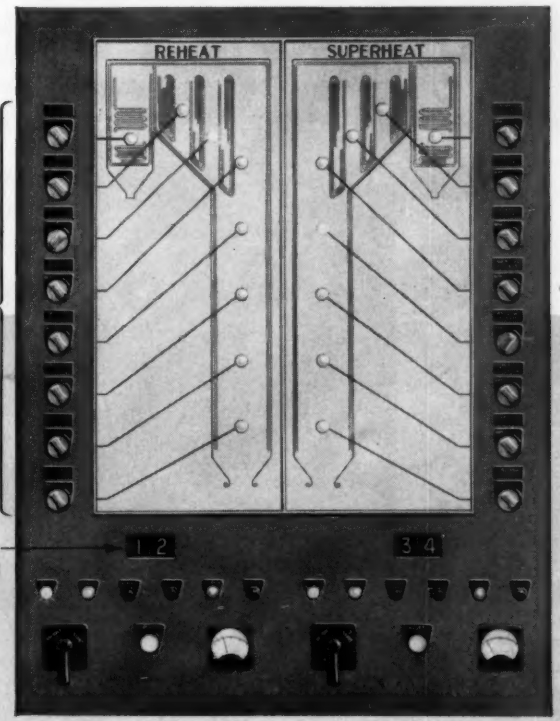
GROUP CONTROL, is designed to accomplish more direct operation of *functional groups* of blowers rather than individual units. Group control is applicable where there is a large number of furnace wall, superheater, reheater and economizer cleaning units which rarely warrant blowing by single units but can rather be operated in groups representing each level of such blowers.

The Group concept can readily be arranged to have physical similarity to the boiler unit itself, with the groups starting at the lowest furnace level and progressing upward through the furnace wall blower levels and on through the superheater and reheater banks, economizer and air heater in logical group sequence.

• • • • • • • • • •

A Diamond Selectromatic* Panel will provide the flexible blower control needed for the most efficient, economical and dependable cleaning of ANY boiler. The automatic sequential operation is easily and quickly changed to meet variable cleaning conditions in the unit. Operators know at all times the operating conditions of the blowers (see top of left page). Protective devices include automatic blower retraction on motor overload, blowing medium failure, and current failure (after restoration). Once a cycle is selected and initiated by the operator, no further attention is needed.

*Selectromatic is a registered trade mark that is a contraction of the functional features of these controls: selective—electric—automatic.

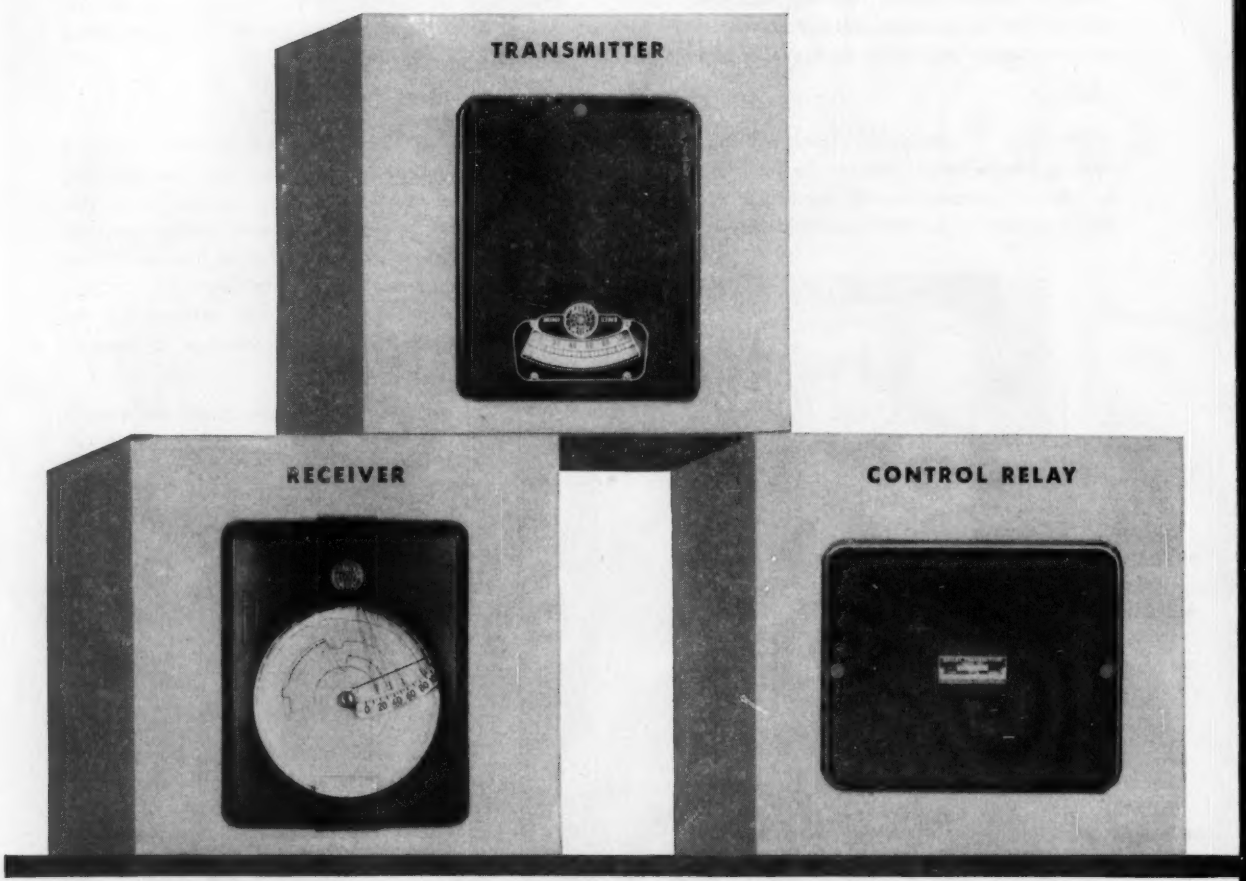


SELECTROMATIC PANEL WITH "GROUP-GRAPHIC" CONTROL AND BOILER DIAGRAM

Simulated boiler interior is pictured on panel to give clear indication of position of each group of blowers. Group in operation is shown by lighting of light on boiler picture. Unit in operation is designated by number below picture. Has all other features of panel shown on left page including variable group sequence and individual blower switch (both internally mounted here but can be external if desired).

CORPORATION | LANCASTER, OHIO
Diamond Specialty Limited • Windsor, Ontario

How to simplify



The Bailey Building Block Method enables you to simplify control problems by combining standardized measuring, transmitting, and controlling components as required.

control problems

Keep systems flexible, carry small inventory, cut maintenance cost with the **Bailey Building Block Method** of instrumentation and control.

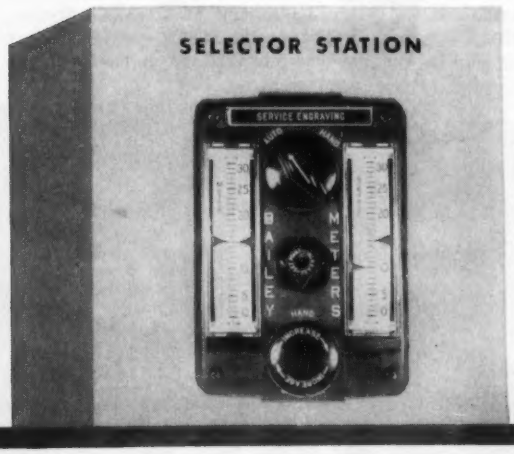
What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

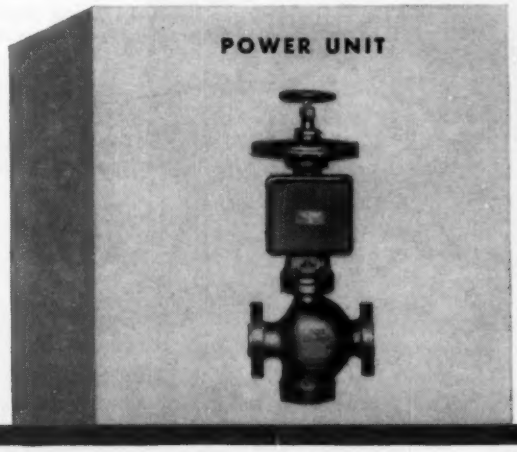
It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is steam flow, tank level, or heater temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

A spare component can be used in any one of many systems. Gone are delays waiting for shipments of special parts. Gone are large inventories of spares and parts. Simplified is the training of men for maintenance.

There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

For further details, call our local district office or write us at Cleveland. Our engineers will be glad to prove how the Building Block approach will save you money and simplify your instrument and control problems.





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BAILEY BUILDING BLOCK METHOD

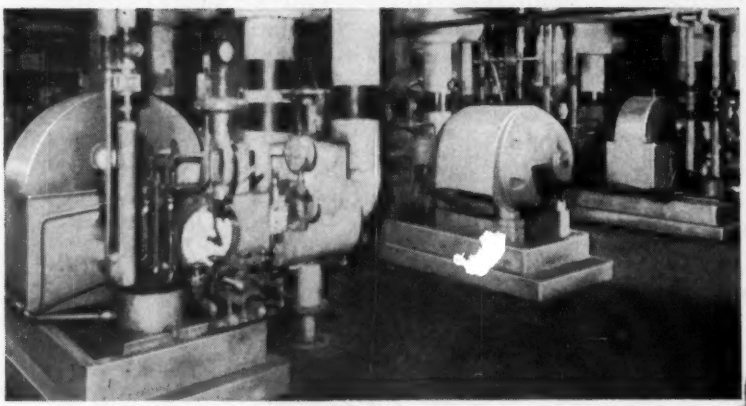
BAILEY METER COMPANY
1036 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

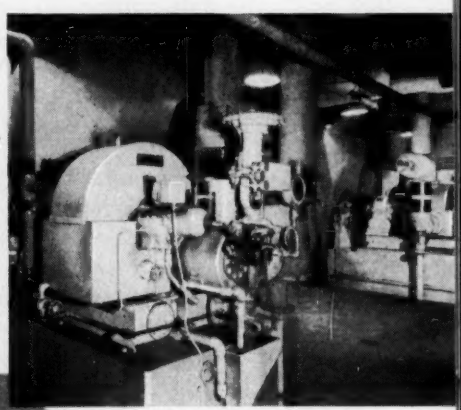
BAILEY METERS

Steam or Electric

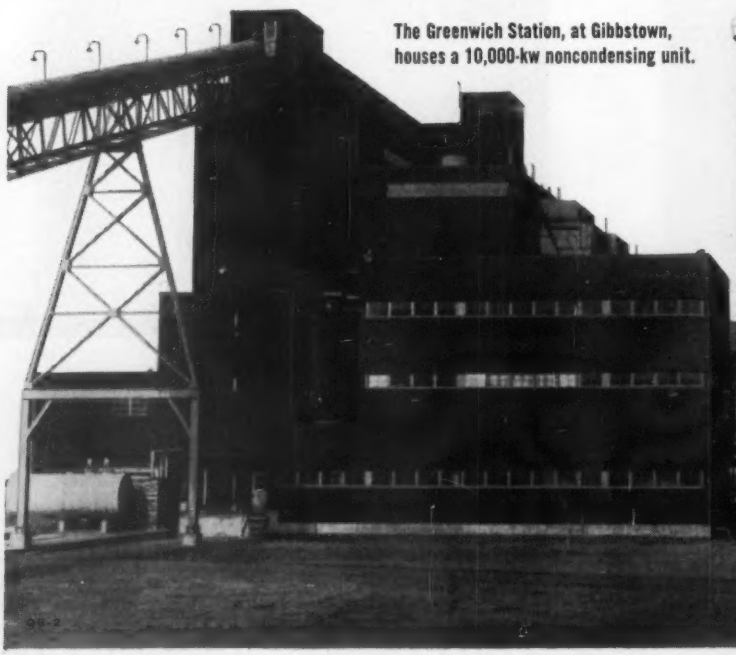
Two Atlantic City Electric Company stations show contrasting use with Elliott Turbines and Motors



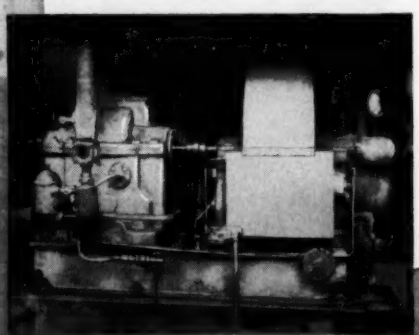
Two Elliott 406-hp, 3550-rpm turbines driving boiler-feed pumps in the Greenwich Station. Turbines take steam at 175 psig, 570 F, and exhaust at 35-psig back pressure. Turbines are suitable for future 700 F operation.



Two Elliott 203-hp, geared turbines driving forced-draft fans at Greenwich Station. Turbines operate at 3570 rpm, which speed is reduced to 1250 rpm on the fans.



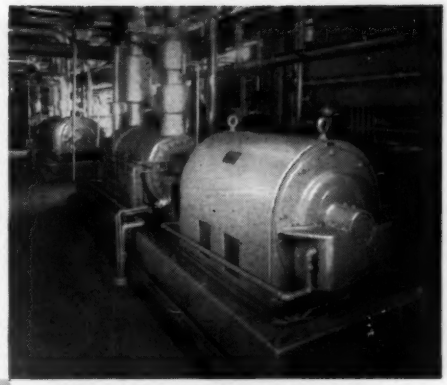
The Greenwich Station, at Gibbstown, houses a 10,000-kw noncondensing unit.

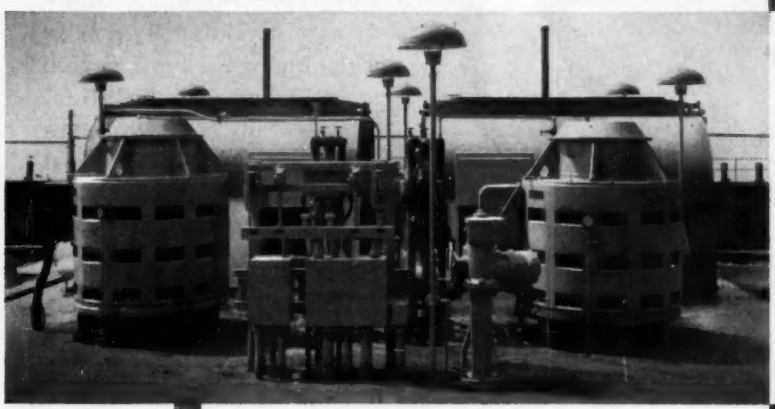


One of two Elliott 450-hp, 3570-rpm turbines driving induced-draft fans at Greenwich Station. Gears reduce speed to 900-rpm. Turbines exhaust at 35 psig.

driven auxiliaries?

● Both the Greenwich Station at Gibbstown, N. J., and the Deepwater Station near Penns Grove, N. J., furnish process steam for industrial use. The Greenwich Station operates a 10,000 kw, 175 psig back-pressure noncondensing unit and so makes use of steam auxiliary drives. The Deepwater Station, however, houses about 185,000 kw of capacity in condensing units in addition to back-pressure turbines for industrial steam supply. Hence it uses the conventional electric motor drive for auxiliaries. In both cases, Elliott machines — mechanical drive turbines and electric motors — are on the job driving boiler-feed pumps, condensate pumps, forced-draft and induced-draft fans. For details, write Elliott Company, Jeannette, Pa.

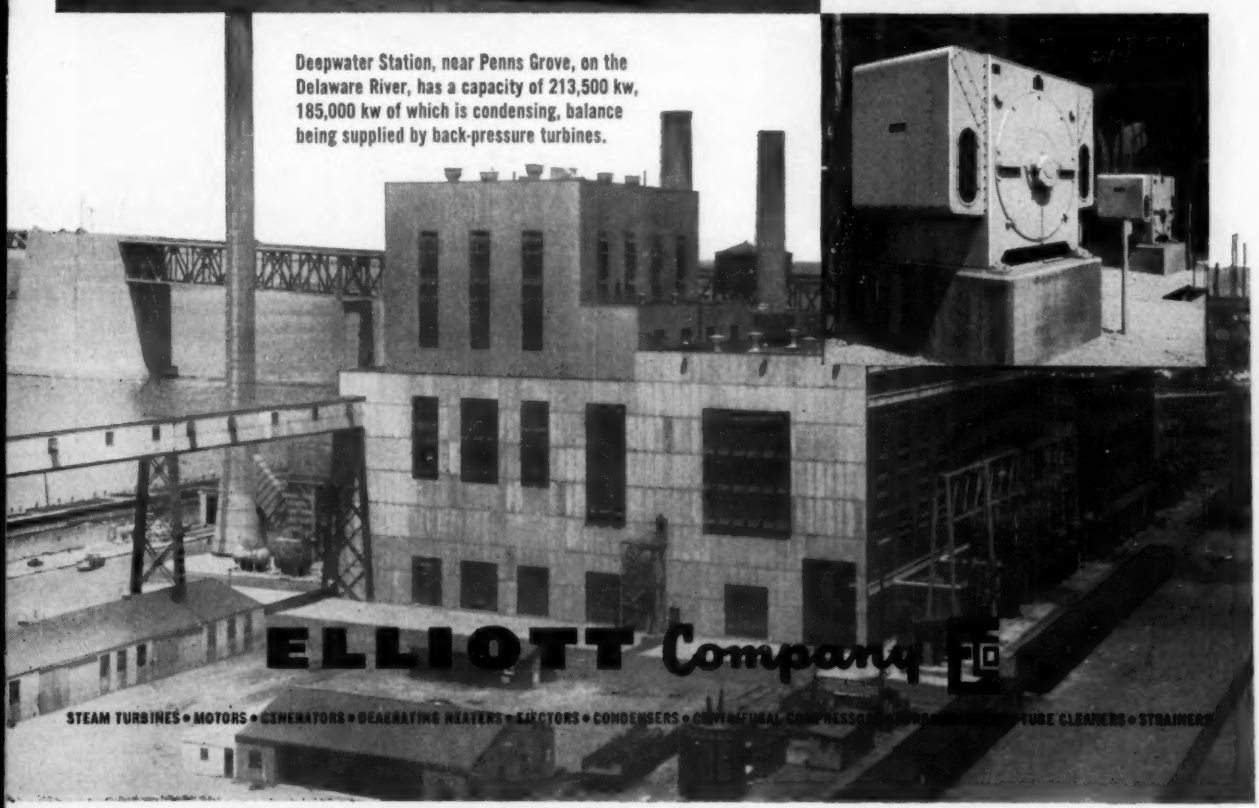




Above are three Elliott 900-hp, 3600-rpm squirrel-cage induction motors driving boiler-feed pumps in the Deepwater Station.

At left are two Elliott 300-hp, 514-rpm vertical outdoor weather-protected motors driving circulating pumps at Deepwater.

Below are outdoor weather-protected motors driving draft fans at Deepwater. In foreground is a 1500-hp, 720-rpm motor driving an i-d fan. The other, a 500-hp, 1200-rpm motor, drives an f-d fan.

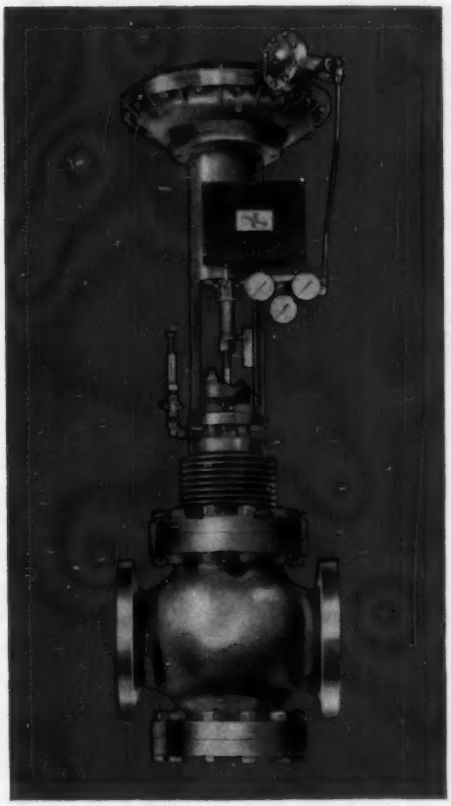

Deepwater Station, near Penns Grove, on the Delaware River, has a capacity of 213,500 kw, 185,000 kw of which is condensing, balance being supplied by back-pressure turbines.
ELLIOTT Company
STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS

NOW

Piston-Type CV-P. For high-duty service. Extremely precise positioning gives you superb operating characteristics. Rangeability is high. Response can be characterized to meet your operating requirements. Designed for those applications which demand the ultimate in valve-operating force . . . where you want the finest valve money can buy. Hand wheel is optional.

Diaphragm-Type CV-D. Either direct or reverse acting. High rangeability. Optional features include: Cooling fins and lubricator for stuffing box that will maintain low friction over longer packing life; hand wheel for emergency operation.

the right valve for more jobs!



Now you can apply high-quality Copes-Vulcan Valves to any application, at unlimited pressures in sizes up to 12 inches. Simplified design gives you this new versatility, plus high standards of performance for broader applications. Too, you will get the Copes-Vulcan custom-design, with ports exactly suited to the requirements of your operation.

Get in touch with your Copes-Vulcan man. He can help you apply the new Copes-Vulcan Valves to your control requirements. You'll get real dollars-and-cents savings in operational cost with less downtime in even those troublesome spots where ordinary valves are inadequate. Write for Bulletin 1027.

COPES-VULCAN DIVISION

BLAW-KNOX COMPANY

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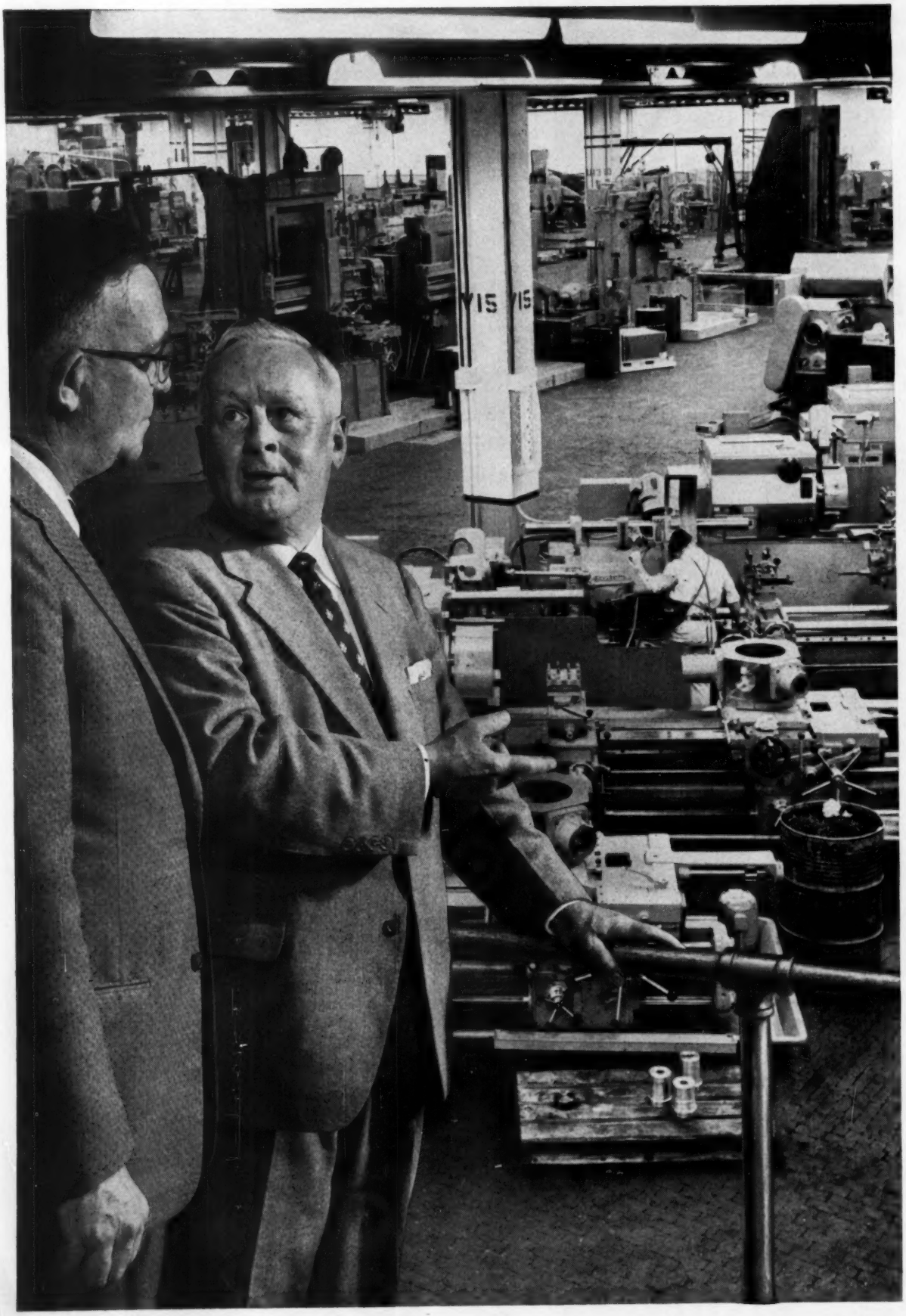
50th Anniversary

BLAW-KNOX

1906-1956



"My boss was stunned when I said . . .

'This plant looks modern... but electrically it's obsolete!' "

"About two years ago the plant manager and I were touring the shop areas. We were half way through when I turned and said, 'This plant looks modern . . . but electrically it's obsolete!'

"As plant electrical services engineer, I got his permission to make a study of our plant power distribution system.

"Even I got a big surprise. We found that the power supply wasn't as safe, dependable or flexible as we required . . . and maintenance costs were getting out of hand. A lot of our electric equipment was antiquated and took up valuable production space.

"We had spent so much time improving manufacturing processes and methods that we had neglected electrical needs. Electrically, we were obsolete . . . and not prepared for the big swing to automation.

"Our plant power distribution system has been modernized since then. We've installed more automatic equipment and work-handling devices, and we are ready to apply more advanced types of automation. Our new branch plant is being provided with electrical adequacy, too.

"You can probably do the same thing we did to get greater efficiency."

J-96101-1

Is your plant suffering from electrical growing pains?

Surveys show that many of the nation's plants are inadequate electrically. A recent study of 42 plants in a given area revealed 88% had electrical problems that interfered with production.

These Problems Can't Wait

	Percent of Plants Inadequate — Electrically*
Inadequate transformer capacity and flexibility	42%
Questionable breaker interrupting capacity	63%
Lack of power centers	62%
Poor power factor	25%
No motor control centers	42%
No plug-in bus duct	32%
Low primary distribution voltage (below 4160 volts)	49%
Low secondary voltage (below 480 volts)	25%
Lack of network distribution systems	90%
Lack of automatic switching to maintain continuity	69%
Absence of 277-volt lighting	94%

*Based on report of survey in 156 top U.S. plants conducted by *Factory* magazine.

WATCH WESTINGHOUSE!

COVER THE PRESIDENTIAL CAMPAIGN ON CBS TV AND RADIO!

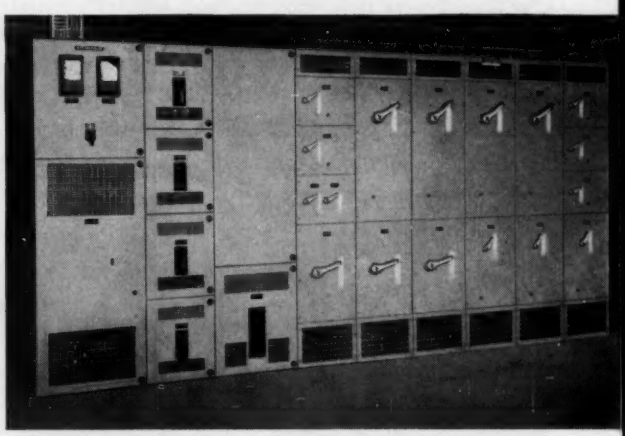
"I called in Westinghouse . . .

Electrical obsolescence disappeared"

Westinghouse switchgear is available in 10 basic units with a selection of standard instrument panels . . . future additions or replacements can be made easily and quickly any time.

"In the process of updating our plant power distribution system, we called upon Westinghouse for expert help. They worked with our staff and consulting engineers to give our plant electrical adequacy.

Westinghouse dry-type transformers save space, mount conveniently in out-of-the-way places. Well suited for wet, dirty or hot locations. Placement close to work load saves long, costly secondary runs.



Expansion with Westinghouse control centers frequently saves as much as 40% on installation costs over decentralized methods of mounting motor control. Inspection and service are simplified.

Switchgear gave us safer, more dependable operation

"We selected Westinghouse low-voltage, metal-enclosed switchgear which gave us high interrupting capacity, assuring safety and operating continuity. It reduced our maintenance, brought economic advantages and freedom to expand our facilities.

"In our new installation, unitized Westinghouse switchgear reduced our special design and engineering expense, and provided custom-built preciseness for our application requirements.

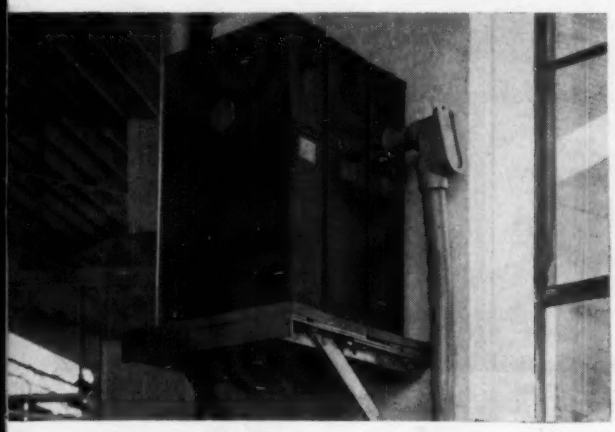
Capacitors paid for themselves in 18 months

"With Westinghouse guidance, we applied capacitors carefully at the substation bus, on secondary bus duct, and right at the motor loads. Savings on our power bill in the first year amounted to 75% of capacitor installed cost. Capacitors paid for themselves in 18 months, and the savings are still going on.

"The capacitors reduced the burden on our feeders and released electrical capacity for other needs. We got better voltage regulation at our motor and lighting loads.

Transformer provided convenient power . . . economically

"We wanted to get power close to the load . . . placing Westinghouse transformers strategically throughout our plant did the job conveniently, economically. For high-impulse levels we used oil- and askarel-filled units, while dry types were used when light weight and ease of installation were vital. I learned that a combination of Hipersil® cores and high-temperature insulation in Westinghouse transformers reduces size and weight one third.



Westinghouse capacitors are low in initial cost, require no maintenance, save additional investment in transformer capacity. Solder-sealed porcelain bushings protect against leaks or contamination of dielectric.

Packaged control simplified system design

"Westinghouse furnished control centers for our permanent machine arrangements. This gave us simplicity in planning and installation, a high degree of safety and flexibility, centralized operation and maintenance.

"Some of our machines were subject to frequent moving. Here we used Westinghouse plug-in bus duct with individual controls at each machine. In both cases, we found that Westinghouse packaged control equipment simplified system design, reduced some costs up to 40%.

"Why not call Westinghouse . . . like I did?"

"I'm sure you'll find Westinghouse a real lifesaver in helping out with your plant power distribution systems, too. Their engineering team will gladly work with your staff and your consulting engineers. I got our plant on the road to electrical adequacy by getting in touch with my local Westinghouse representative."

For more information, call your local Westinghouse sales office or send coupon. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-96101-2

WATCH WESTINGHOUSE!

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Westinghouse Electric Corporation
3 Gateway Center, P. O. Box 868
Pittsburgh 30, Pa.

☐ I would like a showing of the 20-minute film, *Selecting the Right Industrial Distribution System.*

I'm interested in more information about:

☐ Switchgear ☐ Capacitors

☐ Transformers ☐ Controls

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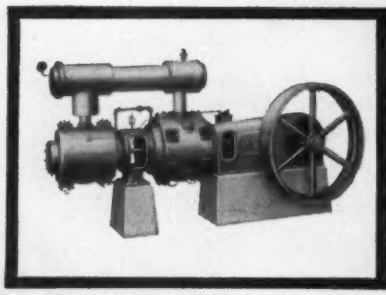
Class T
compressors

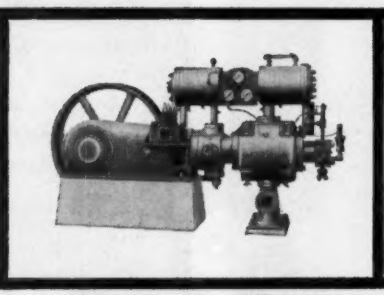
for the plant whose process requirements range from

Vacuum - 7500 psia
up to 150 hp

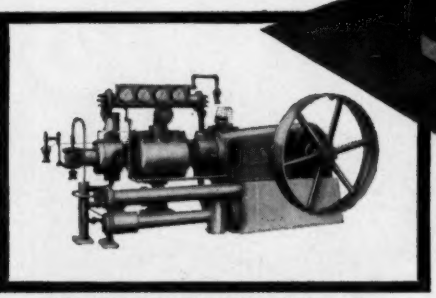
The Class T Compressor is but one of a complete line of CP compressors for process work.
Other types available in sizes to 5,000 HP for pressures to 15,000 psig, with motor, steam or belt drive.



Two-Stage Class TCB-2 Compressor for pressures up to 500 lbs.

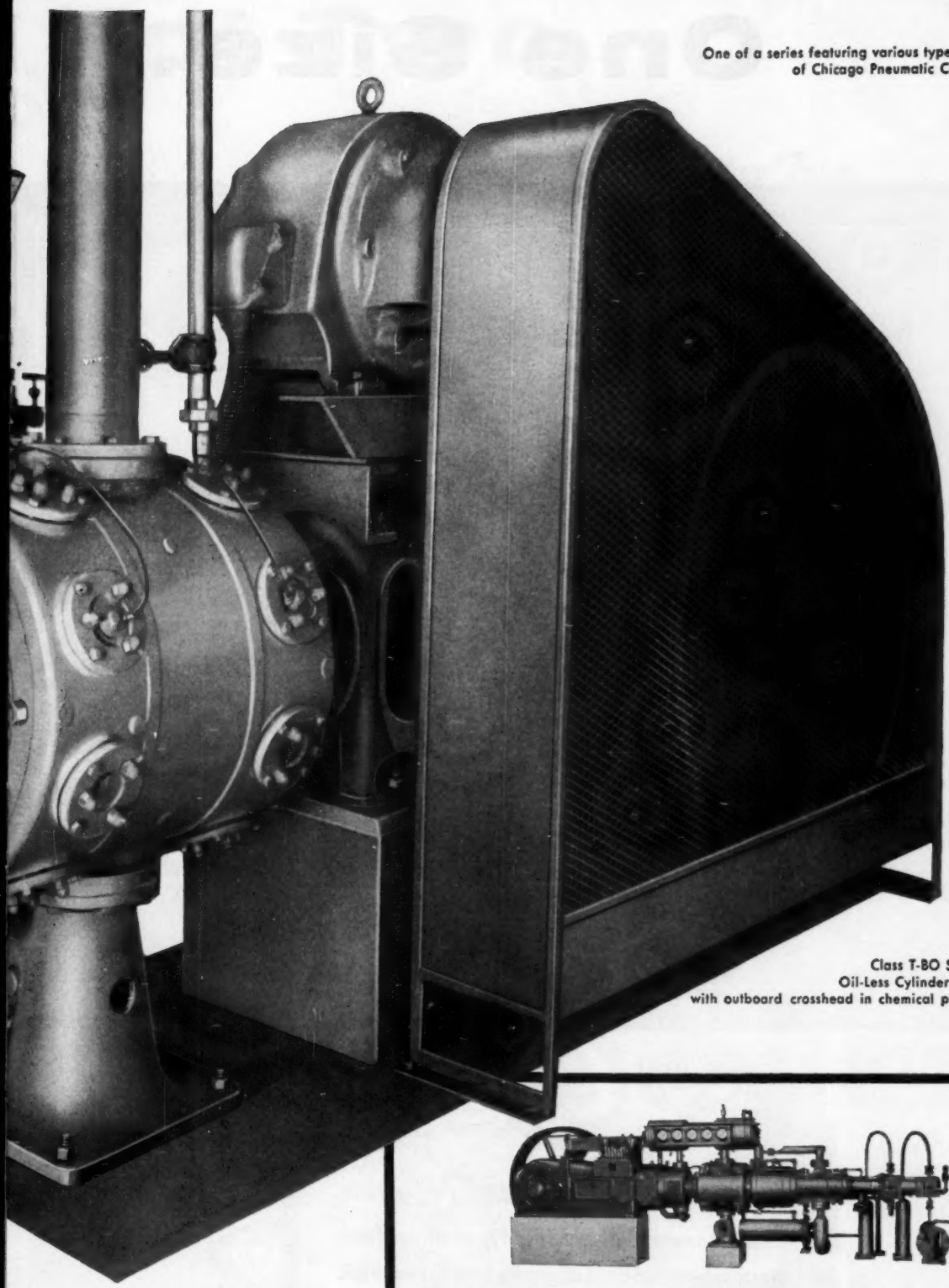


Typical Three-Stage Class T Compressor for pressures up to 2,500 lbs.

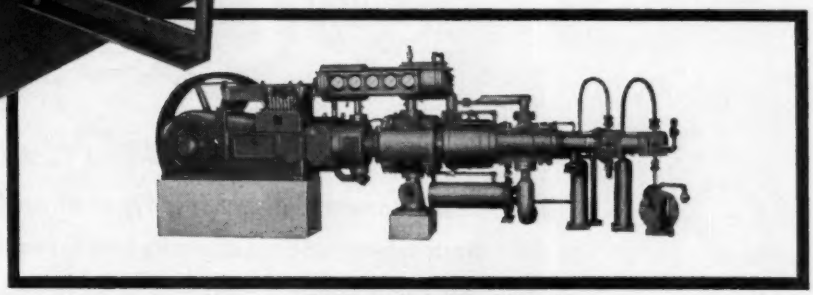


TCB-4 Four-Stage, straight-line Compressor suitable or 6000 lbs. discharge pressure.

One of a series featuring various types and sizes of Chicago Pneumatic Compressors.



Class T-BO Single-Stage
Oil-Less Cylinder Compressor
with outboard crosshead in chemical plant service.



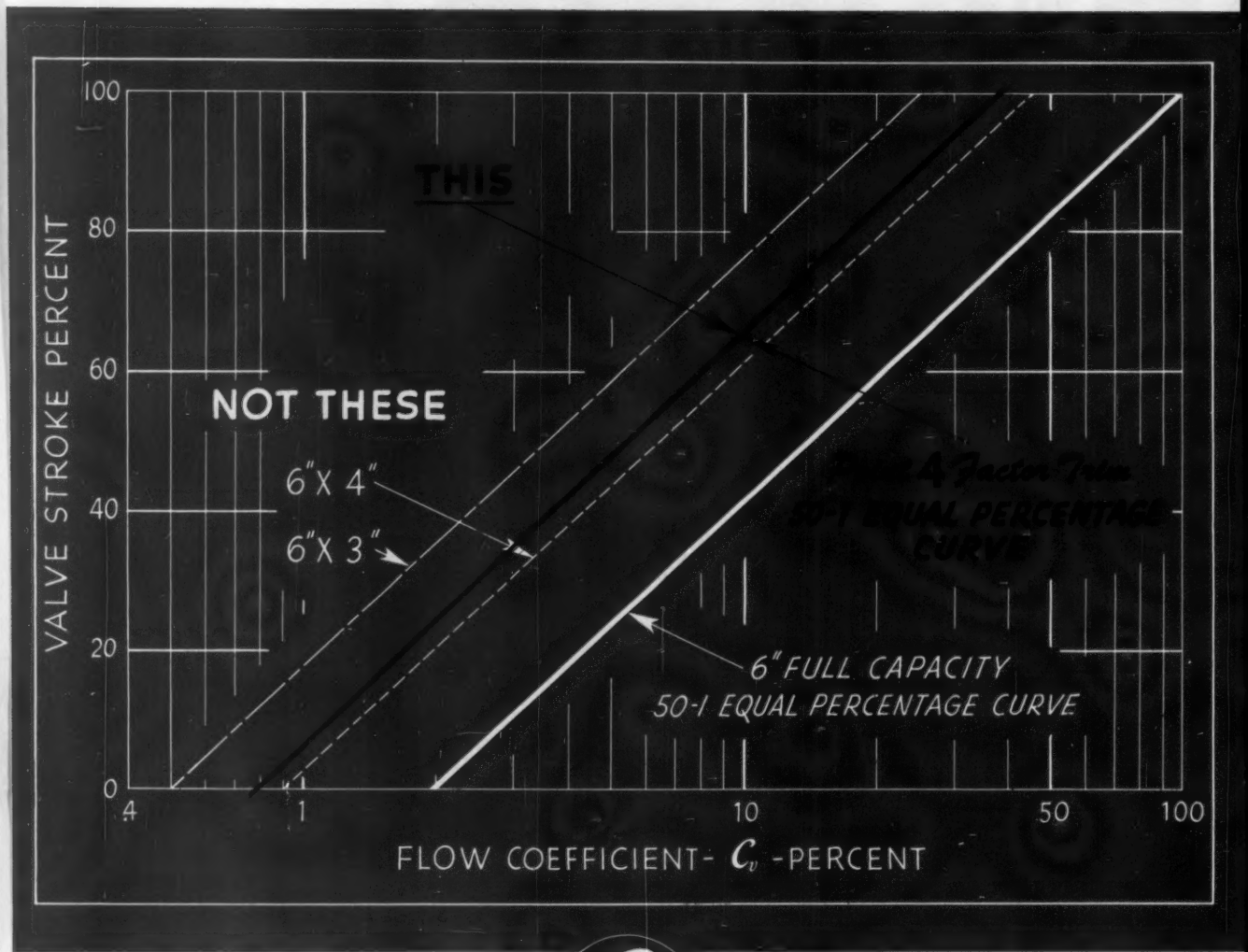
Five-Stage Compressor designed
for 7500 lbs. service.

Chicago Pneumatic

8 East 44th Street, New York 17, N. Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

One Size...



A HIGH Quality Coefficient PRODUCT

Point 4 Factor Trim

is the answer to those few types of applications where reduced capacity trim is required. It is available in V-port and solid turned designs for double or single seated valves and in a wide variety of materials. Send for Data Sheet No. 10-5.

Not Two

Masoneilan *Point 4 Factor Trim* offers the ONLY REALISTIC approach to selection of reduced capacity trim

It is a DEMONSTRABLE Fact that for a given size top-and-bottom guided valve only *one* size reduced capacity trim is:

Desirable from an engineering standpoint because . . .

(a) properly designed wide-range valves with full capacity trim will handle a vast majority of control problems.

(b) if any reduction is required, it must be substantial to be of any advantage.

(c) any sound design must be based on a reduction in seat ring diameter.

(d) rule-of-thumb trim reductions based on nominal *pipe* sizes are unnecessary and merely complicate the sizing problem.

Practical from manufacturing and operating standpoint because . . .

(a) mechanical strength is retained with standard guide and stem diameters and standard stroke, in combination with maximum reduction in seat diameter.

(b) reduction in number of parts simplifies stock problem.

(c) forged and cast forms insure complete uniformity of parts.

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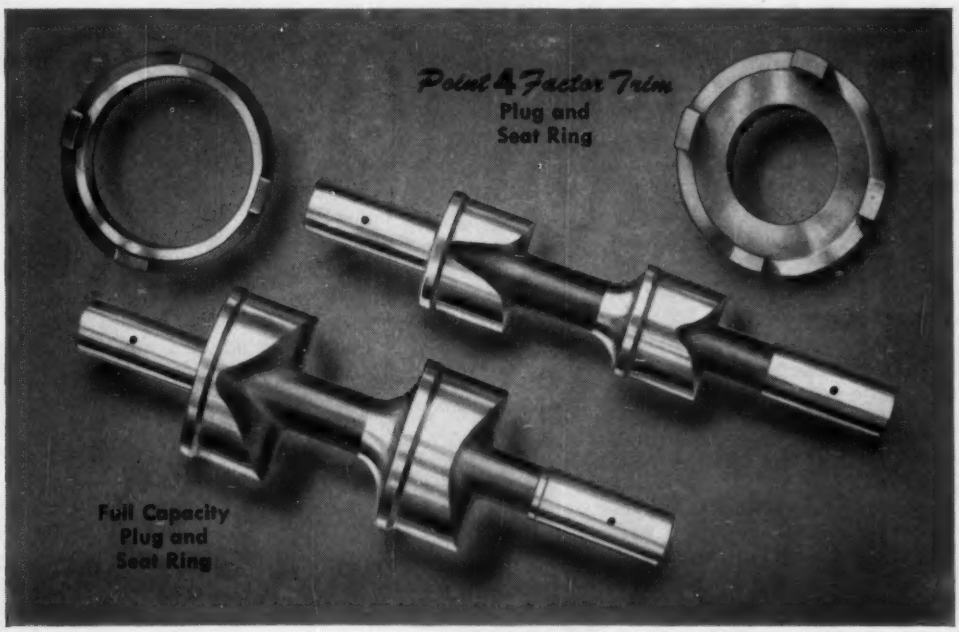
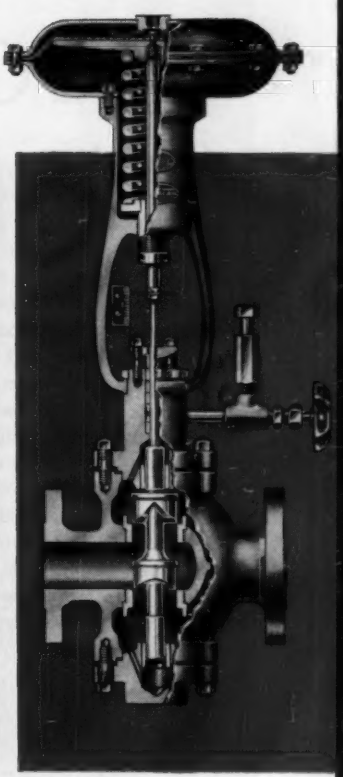


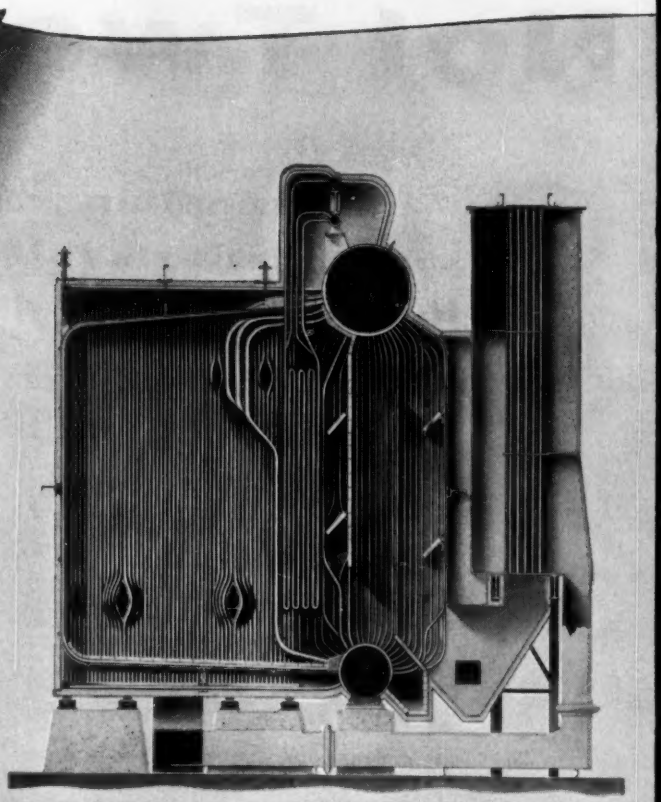


one of these C-E standard boilers is....

DESIGNED FOR YOUR PLANT

If your steam needs range between 4,000 and 120,000 pounds per hour, one of these versatile C-E Boilers will give you economical, standout performance. For while they are standard in design (which means lower first cost and proven performance), they're still *flexible* enough to be easily adapted to your exact requirements.

Chances are that one of the C-E standard boilers is the answer to your steam needs. But whatever they may be, C-E can fill them. For C-E Boilers are made in sizes and types for *any* capacity—for *any* pressure—*any* fuel or method of firing.

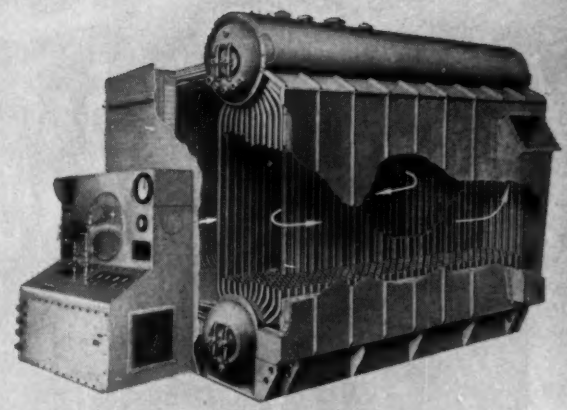


C-E Vertical Unit Boiler, Type VU-55

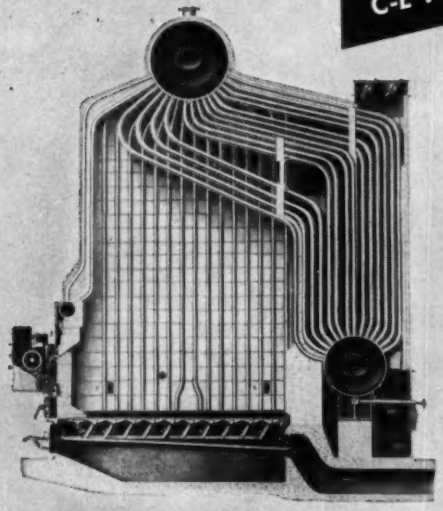
The VU-55 Boiler is available in five sizes ranging from 50,000 to 120,000 lb of steam per hr. It is designed for pressures from 250 to 750 psi for all sizes and for up to 300 degrees F of superheat. Heat recovery equipment may be added if desired. VU-55 Boilers are designed for the pressure firing of oil or gaseous fuel and require no induced draft fan. They are equipped with tangential burners and tangent furnace tubes to assure a level of performance which compares favorably with modern utility practice. Shop assembly of furnace wall panels and boiler screen tubes saves time and money in handling, transportation and erection. The absence of outside downcomer tubes and ducts makes possible the attractive, streamlined exterior of the VU-55.

C-E Package Boiler, Type VP

This completely shop-assembled boiler is available in fourteen sizes from 4,000 to 40,000 pounds of steam per hour ... for operating pressures up to 500 psi ... for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum—30-inch diameter—permits a simple, symmetrical tube arrangement ... greater water storage capacity ... easy access for washing down or inspection. A centrifugal fan, which operates at low speed and is exceptionally quiet in operation, is standard equipment. The simple baffle arrangement results in low draft loss ... simple soot blowing ... no dead pockets ... high heat absorption. The VP is enclosed in a reinforced gastight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.



C-E Vertical Unit Boiler, Type VU-10



The VU-10 is available in nine sizes from 10,000 to 60,000 pounds of steam per hour ... for operating pressures up to 475 psi ... superheat to 200° F in 20,000-60,000 lb range ... for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit—boiler, furnace, setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.

A C-E Industrial Boiler for Every Need — Combustion Boilers are available in many other 2-drum designs — for capacities up to 350,000 pounds of steam per hour — and to burn any commercially available fuel. All of these boilers can be designed for use with pressures up to 1375 psi and steam temperatures as high as 960 F—utilize any type of steam recovery equipment—fit difficult space conditions. Let us give you full details on the complete line of C-E Industrial Boilers, including the C-E LaMont Controlled Circulation Hot Water Boilers.

B-852D

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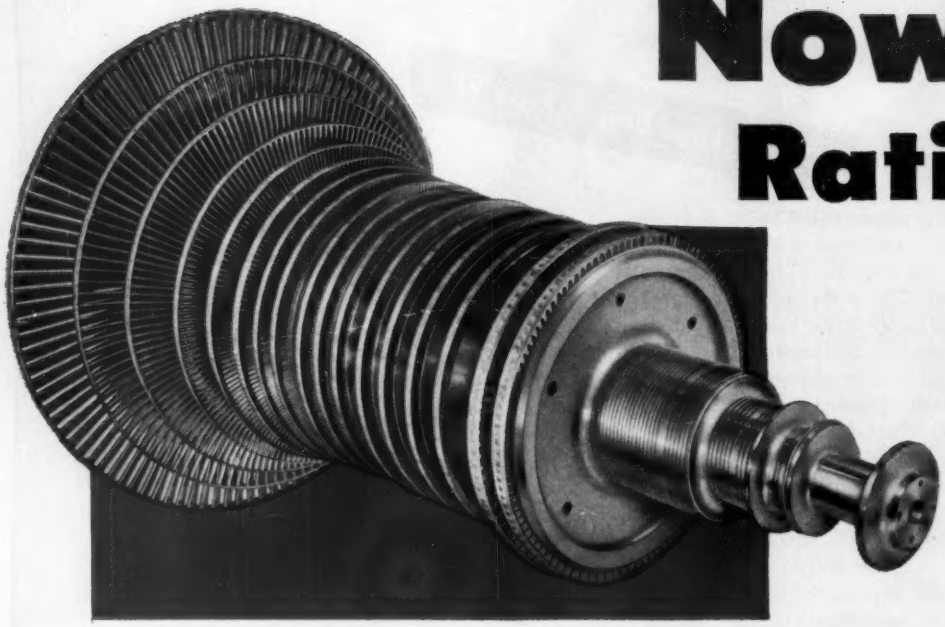
CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

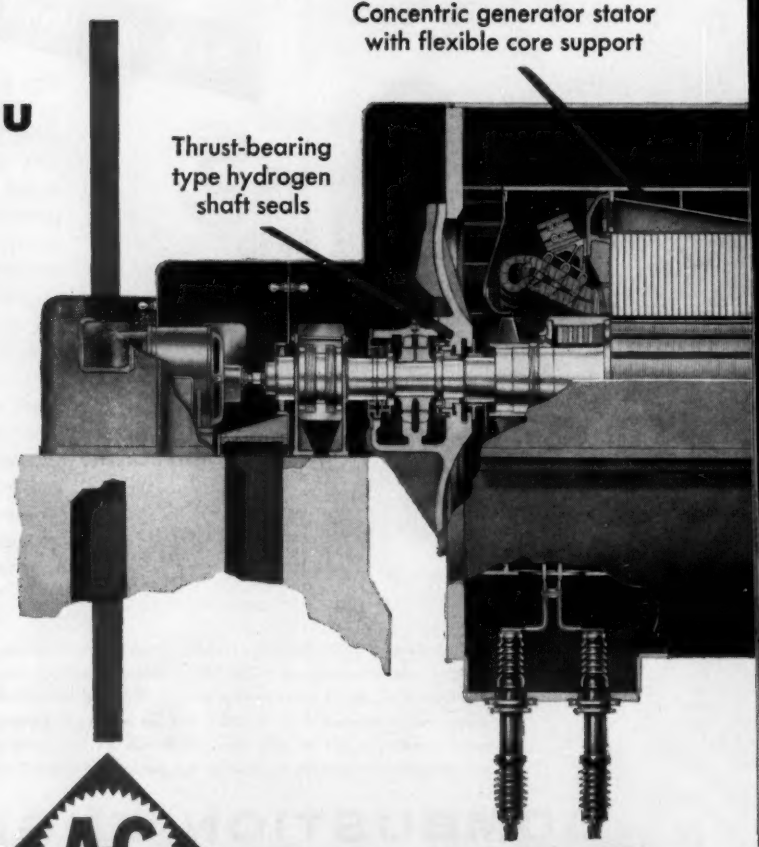
STEAM GENERATING UNITS; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; DOMESTIC WATER HEATERS; SOIL PIPE

Now in Ratings



Here is the turbine rotor for one of the 16,500-kw units now being built. For this 850-psig, 900-F AIEE-ASME turbine, rotor shaft and wheels are of integrally forged construction.

Allis-Chalmers Turbines Give You MORE Modern Design Features



CUTAWAY VIEW of 16,500-kw unit shows the development of impulse turbine design for larger ratings.

A-C ALLIS-CHALMERS

ALLIS-

Production up to 16,500 Kw

NEW Large WA-Series Turbines Offer

Advanced ● Design Features

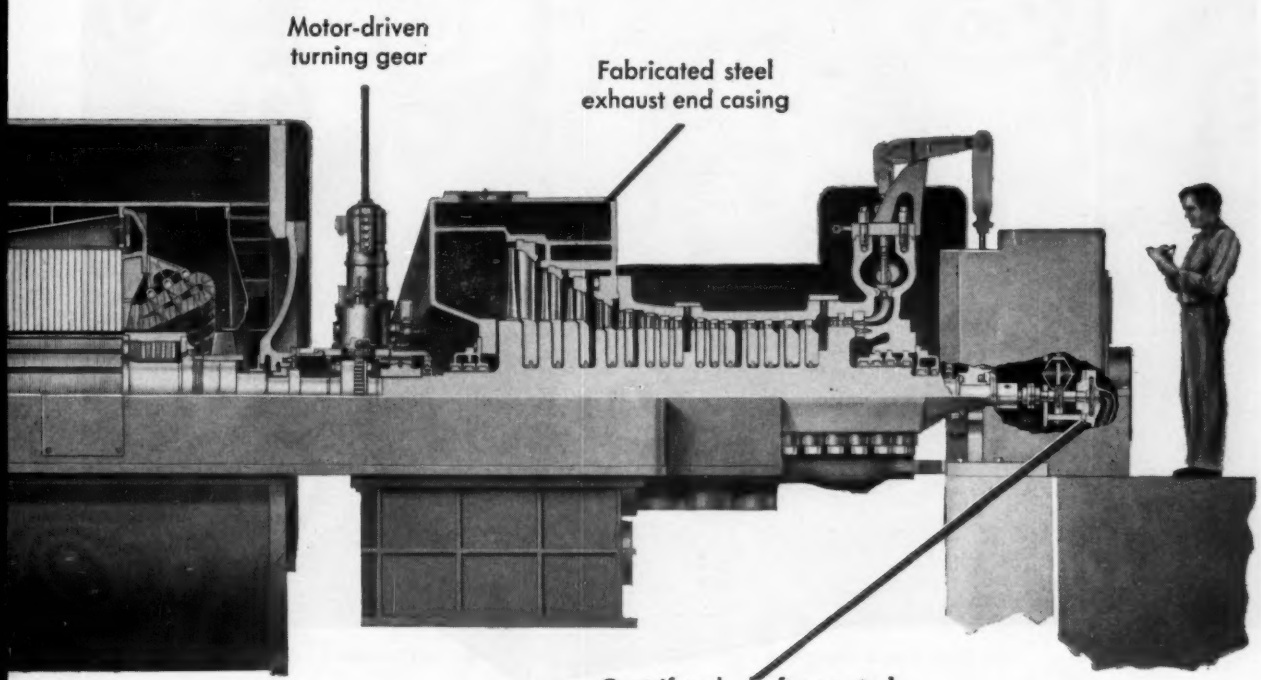
Simplified ● Installation

AIEE-ASME ● and NEMA Ratings

NEW WA-Series steam turbine-generator units now being manufactured include the 10,000-kw NEMA standard rating as well as 12,650-kw and 16,500-kw AIEE-ASME preferred standard condensing ratings. The 16,500-kw units have hydrogen-cooled generators.

Incorporated in the design are time-proved labyrinth steam sealing, removable external glands, high chrome alloy steel buckets and nozzles, reliable governing system, and unit shipment and installation — plus additional large turbine and generator features.

To get MORE information on economical, dependable units 2000 kw and larger, call the nearest A-C district office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.



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LIVE BETTER ELECTRICALLY

A-5127

"BUFFALO" TYPE "CR" RADIAL BLADE FAN

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT

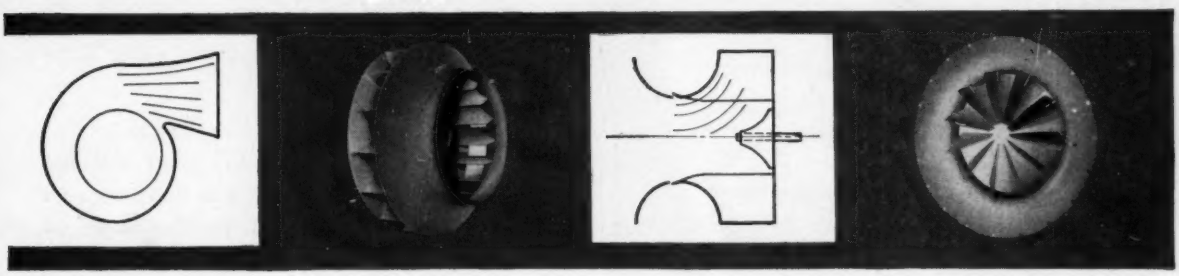
Engineered for high volume-high pressure service

Already proving its overall economy in stoker-fired induced draft, cement plant and other heavy-duty industrial service, this newest "Buffalo" Fan has the following advantages:

- **HIGH** Mechanical Efficiency — above 78% over a wide range.
- **DESIGNED** for high dust loading conditions.
- **LOWER** First Cost, when its high pressure, high capacity characteristics mean a smaller fan for the job.

Ilustrated here are the features that contribute to this desirable balance of efficiency and resistance to abrasion — the streamlined housing with diverging outlet — the new radial wheel with its deep, smoothly curved inlet flange mating with the inlet bell to form a true half-circle entry into the wheel. The wheel blades are radial at the tip, curving smoothly forward at the inlet. Further, "Buffalo" CR Fans are designed for use with an open inlet or with the highly efficient "Buffalo" variable inlet vanes shown.

WRITE FOR BULLETIN FD 205 and check the "Q" Factor* features that will give you the greatest all-around satisfaction and economy with this quality fan.



STREAMLINED HOUSING and diverging outlet aid efficiency, reduce abrasive effect.

TYPE "CR" RADIAL WHEEL — note how mating flanges of inlet bell and wheel flange form a true half-circle entry path with no flat sections or irregularities.

ACCURATE VOLUME CONTROL without reducing fan performance is obtained with "Buffalo" cantilevered variable inlet vanes set well into inlet bell throat.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

"this is

● Engineers tell us Yarway Remote Liquid Level Indicators are the most dependable boiler insurance they can have.

Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

Write for the specific bulletins you want.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

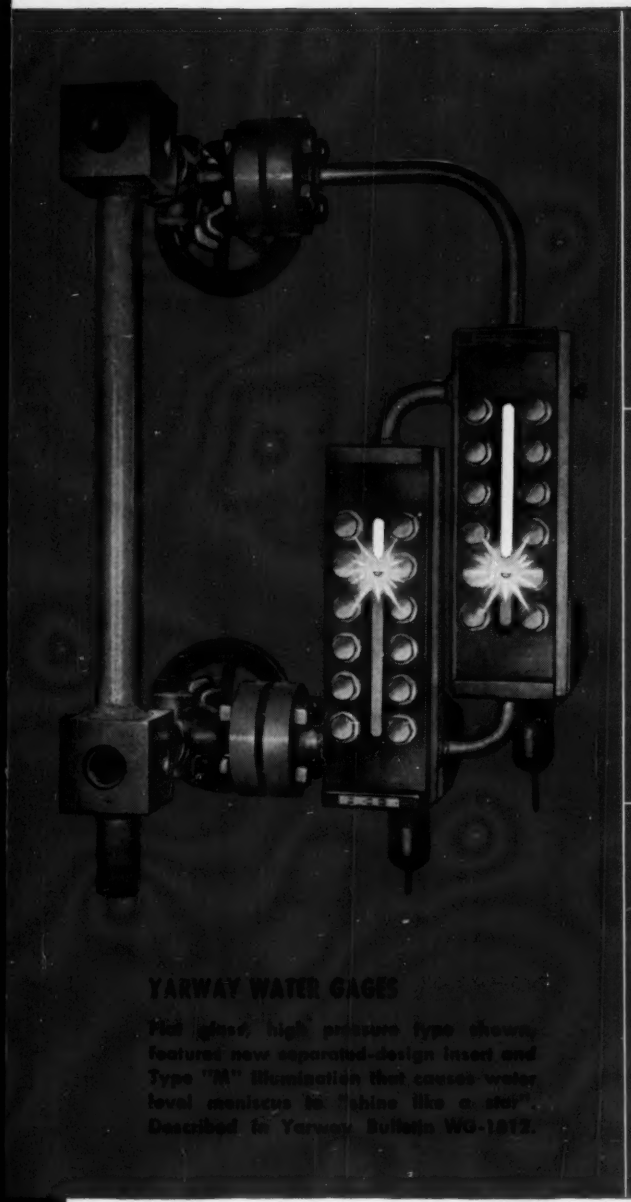
WIDE VISION!

Clear, brilliant readings from any angle, are possible with the "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case #1155.

Described in Yarway Bulletin WG-1824.

good boiler insurance!"



YARWAY WATER GAGES

Flat glass, high pressure type showing, featured new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights on boiler, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

YARWAY TELEVISION

Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant. Described in Yarway Bulletin WG-1813.

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

COCHRANE . . . FIRST IN WATER CONDITIONING

Versatile

cold water softening and clarification

The Cochrane Solids-Contact Reactor provides a versatile cold process for the removal of turbidity, color, alkalinity, silica, fluorides, etc., from well or surface waters.

It is used extensively in the chemical, paper, plating and processing fields. Cochrane Reactors are used for the recovery of fiber from white water in paper mills. They are an accepted pre-treatment for demineralization of boiler feed water and of water used in tin plating. They are also widely used for water clarification in oil field flooding.

The "catalytic effect" offered by the Cochrane design accelerates growth of newly-formed precipitates, producing clear water faster and with less chemical, thereby providing savings in investment in tank size requirements as well as in operating cost.

Cochrane's Complete Line and Water Conditioning Service assures you of unbiased recommendations. Consult Cochrane first. Write for Publication 5001-A.

Cochrane

CORPORATION

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Representatives in 30 principal cities in U.S.; Paris, France; La Spezia, Italy; Mexico City, Mexico; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii; Manila, Philippine Islands.

Pottstown Metal Prods. Div.—Custom built carbon steel and alloy products.

COCHRANE CORPORATION · WATER CONDITIONING ENGINEERS · SINCE 1863 · PHILADELPHIA

Demineralizers • Zeolite Softeners • Hot Process Softeners • Hot Lime Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Pressure Filters Continuous Blowoff Systems • Condensate Return Systems • Steam Specialties

As production demands increase . . .

Your power distribution system is a major key to expanded output

MAKE SURE IT INCLUDES ALL THESE VITAL CHARACTERISTICS—

RELIABILITY is essential to assure vital power for intensified operations in growing plants. On critical lines, production stoppages can cost more than power distribution system equipment.

ECONOMY of system should keep first costs reasonable, provide low operating costs, hold maintenance to a minimum.

SAFETY must be assured for personnel and equipment. If equipment is *inadequate or misapplied,* increased production with its greater use of electricity can mean more dangers.

FLEXIBILITY is required to make sure system meets changing production requirements. Relocation of machines, higher load density, special loads must all be provided for.

EXPANSIBILITY prevents early obsolescence of system by facilitating addition of capacity to serve higher loads or new production areas.

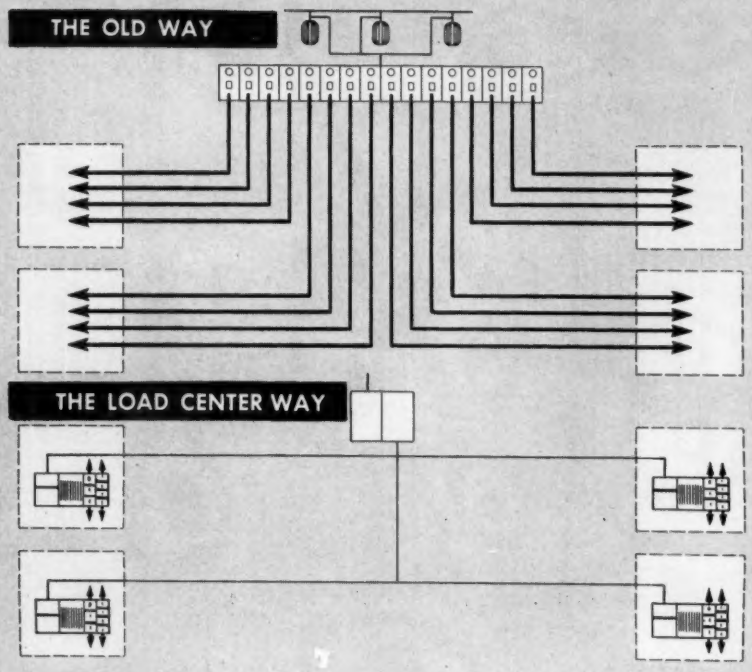
To help you achieve all these benefits in your system, General Electric presents the 8-Point Power Distribution Program found on the following pages.

GENERAL ELECTRIC

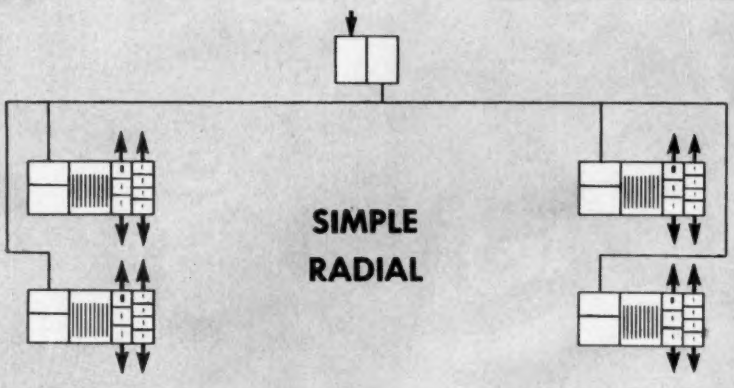
SEE GENERAL ELECTRIC'S 8 POINT POWER DISTRIBUTION PROGRAM

Point 1 USE LOAD-CENTER SYSTEM

. . . with General Electric substations to lower first costs, provide "building blocks" of power for expansion

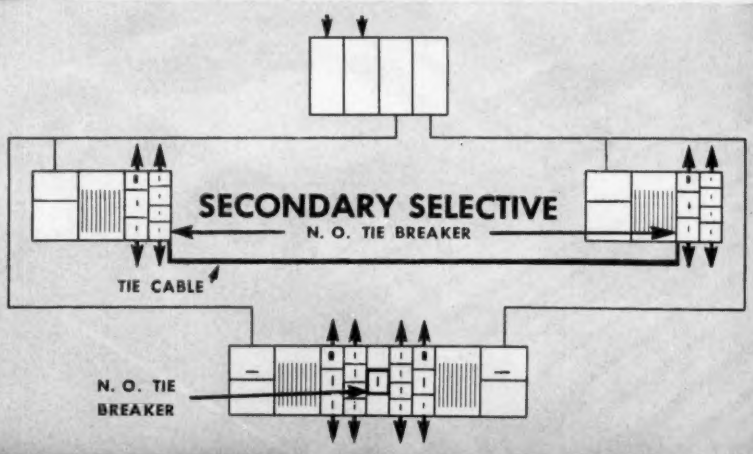


25 PERCENT SAVING is possible with load-center system. This is due to lower costs of cable, busway, and breakers despite need for more transformer capacity. Long low-voltage feeders often caused up to 20 percent voltage drop.



BASIC CIRCUIT is simple radial. Single primary feeds through metal-clad switchgear to substations in load areas. Since General Electric equipment has extremely low failure rates, system can have up to 99+ per cent reliability.

MORE RELIABILITY, flexibility, comes with secondary selective system. Radial primaries feed separate subs. Normally-open tie breakers can be closed to provide power from companion substation if normal supply is interrupted. System gives all reliability normally needed, costs 25-50% less than more complex methods. Its simplicity minimizes confusion during emergencies.



Many advantages emphasize why load-center systems are rapidly replacing the old method of transforming power at one location and distributing it in long low-voltage feeders.

LOWER COST of load-center system comes from savings in copper and more economical switchgear. High-voltage feeders bring power close to load allowing great savings in copper from use of short low-voltage feeders. More economical feeder breakers can be used since short-circuit duty is less.

LESS VOLTAGE DROP—usually less than one percent in secondary feeders—results from shorter secondary circuits.

SIMPLIFIED ENGINEERING, INSTALLATION save valuable time, help cut costs. Factory-engineered substations are easily specified by catalog number. Units are factory-assembled, shipped ready for fast installation.

MORE FLEXIBILITY, EXPANSIBILITY make it easier to relocate or expand to meet new production needs. New blocks of power can be installed, existing ones enlarged when and where needed.

Correct application of system requires full line of high-quality substations such as General Electric units on facing page. For more information use coupon on last page of this ad.

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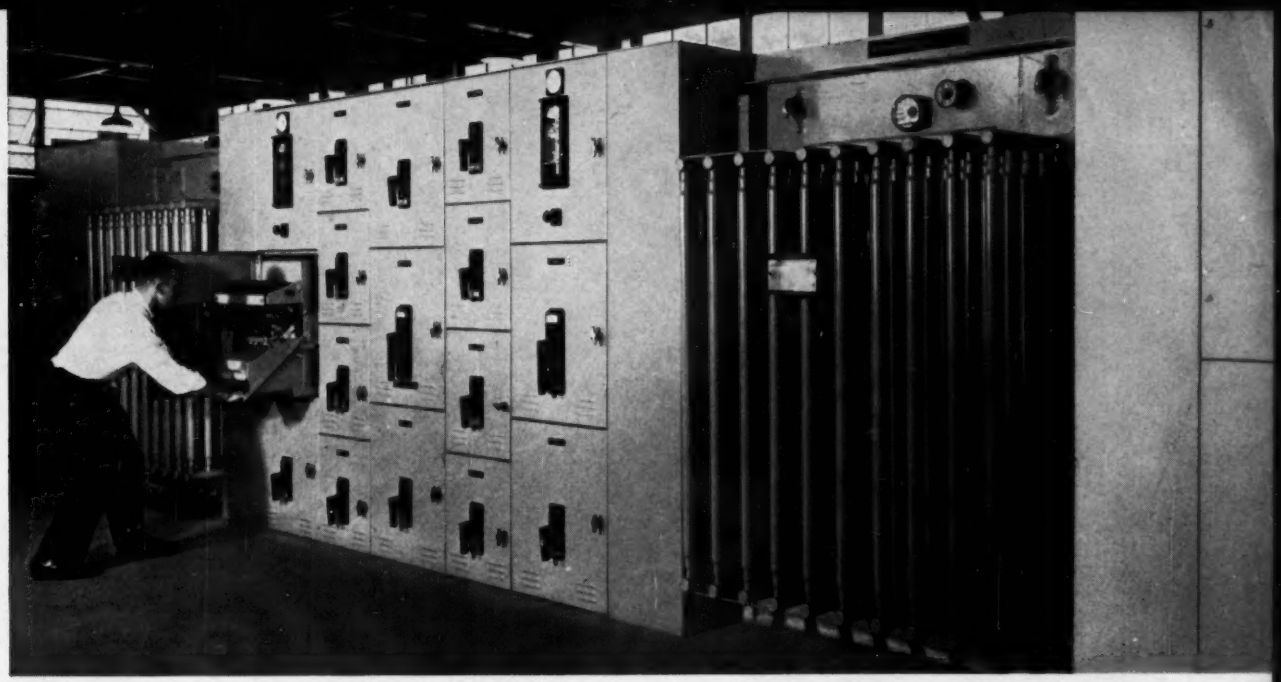
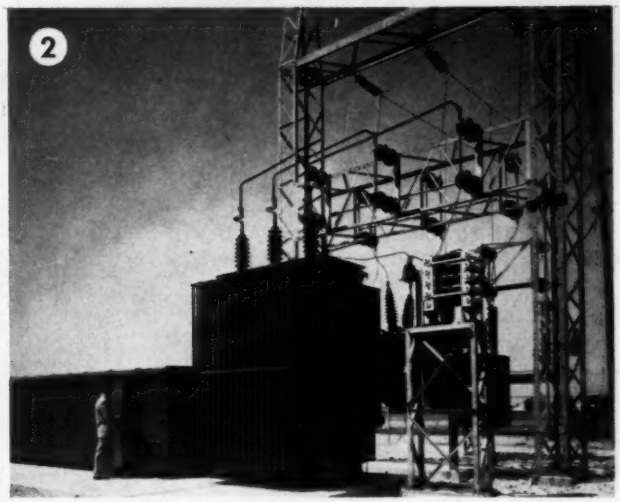
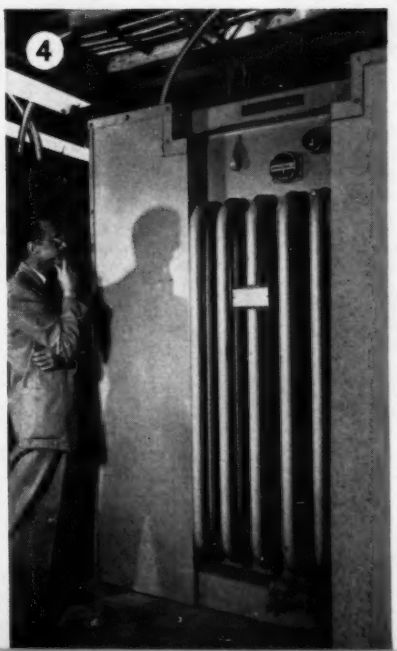


KEYSTONE OF SYSTEM is load-center unit substation. Typical General Electric units are single or double ended, have Pyranol* filled (above) or dry-type transformers. Cost comparisons show most economical sizes to be 750–1000 kva at 480 volts.





FULL LINE INCLUDES—

1. PACKAGE substation which includes transformers, circuit breakers, structures, etc., for handling very high voltages such as 138 or 69 kv.

2. MASTER unit substations that reduce high primary service voltages to levels below 15 kv for distribution in buildings.

3. INDUSTRY CONTROL center unit substation with secondary section of control units such as Cabinetrol* starters, shown, instead of circuit breakers.

4. DISTRIBUTION center unit substations, either integral or sectional—ideal for small load-areas—serve up to 500 kva.

*Reg. Trade Mark of General Electric Co.

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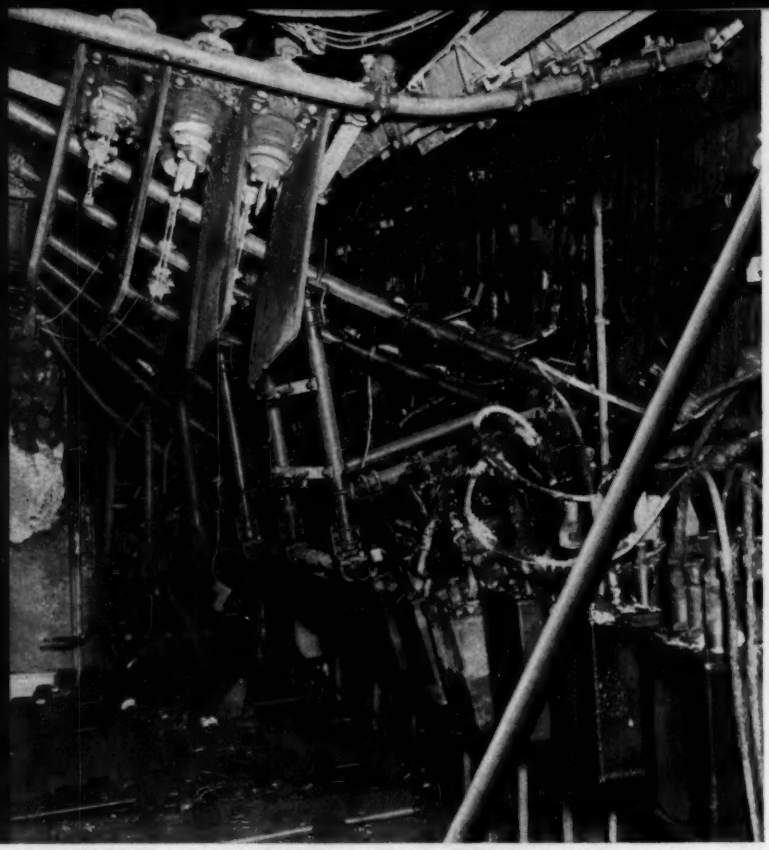
TURN PAGE FOR POINT 2

Point 2 PROVIDE ADEQUATE IC (Interrupting Capacity)

. . . by properly applying General Electric equipment to protect apparatus, personnel from short circuits



COULD THIS HAPPEN IN YOUR PLANT? Just because you have never had a bad short circuit is no sign you won't. Inadequate switchgear is like a bomb waiting to be set off. The explosion of this inadequate circuit breaker caused obvious destruction, long disruption of service, and could have cost lives.

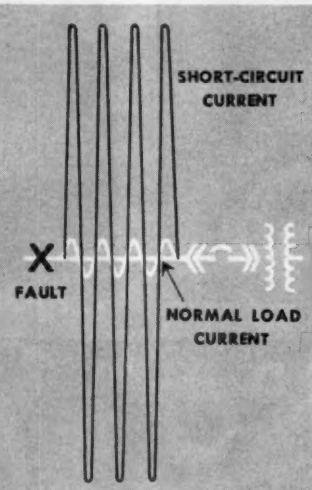
Adequate interrupting capacity means two things. First, circuit protective devices must be able to interrupt **normal load current** drawn by utilization equipment on their circuits. Second, they must be able to interrupt high **short-circuit currents** possible in case of a fault on that circuit.

MOST IMPORTANT in selecting adequately rated protective equipment is the short-circuit current. This is because it is potentially much larger than load current.

Load current depends on the load connected to the circuit. Short-circuit current has little relationship to connected load. It is determined by size of system of which it is a part—the size of transformer and connected motors.

An example of some typical short-circuit currents appears at right. Qualified power system engineers will be glad to help you determine current conditions in your plant.

TO ASSURE ADEQUATE IC after current values are known, select only protective devices of tested, proved capacity—and allow ample capacity for growth. For more details mail coupon on last page of ad.



CAN YOUR BREAKERS INTERRUPT THIS CURRENT? The sketch at left shows the typical difference in magnitudes of normal load current and short-circuit current. The latter can be even greater than 100 times the load current, making it apparent why breakers cannot be rated solely on current drawn by load.

The chart below indicates some short-circuit currents available with different transformers and systems.

SHORT-CIRCUIT CURRENT AVAILABLE ON 480-VOLT, 3-PHASE SECONDARY SYSTEMS (in amperes)

SUBSTATION RATING	Short-circuit KVA Available from Primary System			
	50,000	150,000	500,000	Unlimited
500 KVA	15,500	17,100	17,800	18,100
750 KVA	20,600	23,300	24,500	25,000
1000 KVA	26,100	30,400	32,400	33,400
1500 KVA	35,600	43,800	47,900	50,100

(Assuming 100% motor load)

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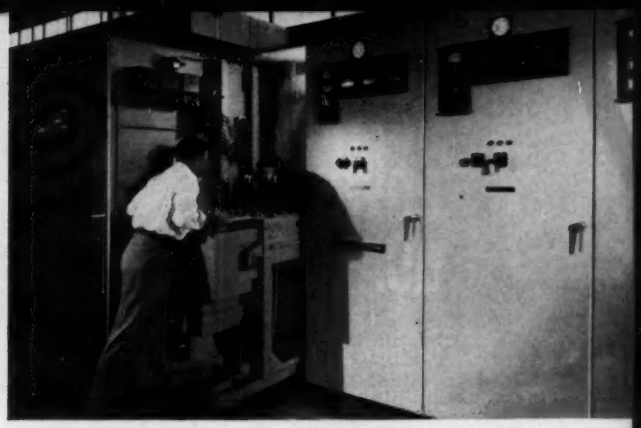
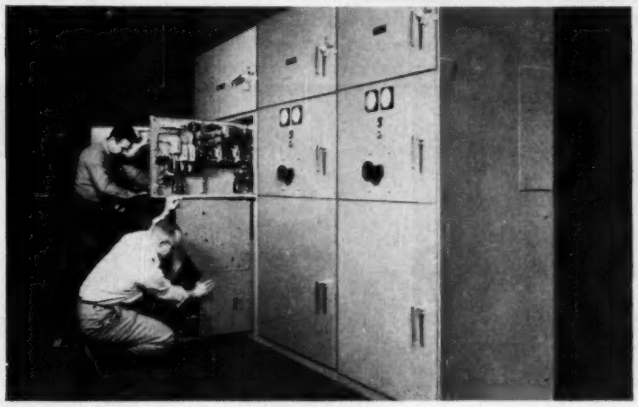
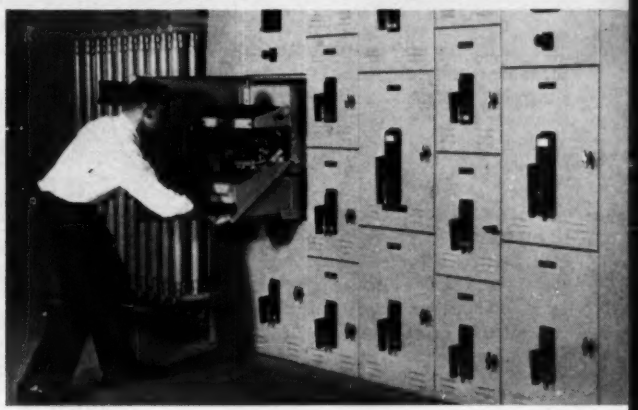
HIGHLY RELIABLE protection of service entrance when power above 15 kv is used, comes from General Electric oil-filled power circuit breakers. Capacity of these may be key to all expansion.



HIGH SAFETY is provided by metal-clad switchgear. Metal enclosures protect personnel while well-tested, magne-blast breakers help protect 2.4 to 13.8-kv power circuits.



ALL-NEW Limitamp* control provides modern protection, control of high-voltage motors (2.3-4.8 kv). Units have 60,000-amp momentary IC, and take only ½ the space of previous models.



MAINSTAYS of system IC are draw-out air circuit breakers for protection, switching of circuits up to 600 v. Recent up-rating offers new opportunities for economical applications.

CUSTOM ASSEMBLED or standard motor control centers economically protect, control low-voltage motors.

DEPENDABLE protection of medium-to-large branch circuits up to 600 v can be obtained with Type AK individually mounted circuit breakers.

VERSATILE molded-case circuit breakers are available in ratings up to 600 v, 800 amps for small to medium circuits.

IDEAL for use as final protective device, quick-make, quick-break Type HCI safety switches utilize fast-acting CLF current-limiting fuses.

SAFER, convenient control of lighting or power circuits is assured by panelboards with CLF fuses or breakers.

*Reg. Trade Mark of General Electric Co.

Turn page for Points 3 through 7 of program

Point 3 IMPROVE POWER QUALITY

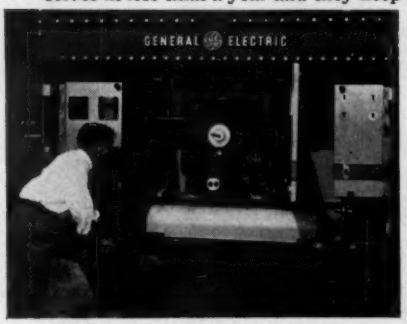
. . . to cut power costs, increase equipment efficiency

POWER-FACTOR CORRECTION may reduce power costs, increases feeder capacity up to 30 percent. General Electric capacitors, like one above, can pay for themselves in less than a year and they keep paying off year after year in dollar savings.

As automated manufacturing increases and electrical loads grow heavier, improvement of power quality becomes more necessary and rewarding.

Low power factor may increase power costs (where pf penalty clause exists) and reduce feeder and substation capacity. Voltage variations can mean sacrifice of life or performance of equipment—or both.

Economical General Electric equipment is available to help assure good power quality.



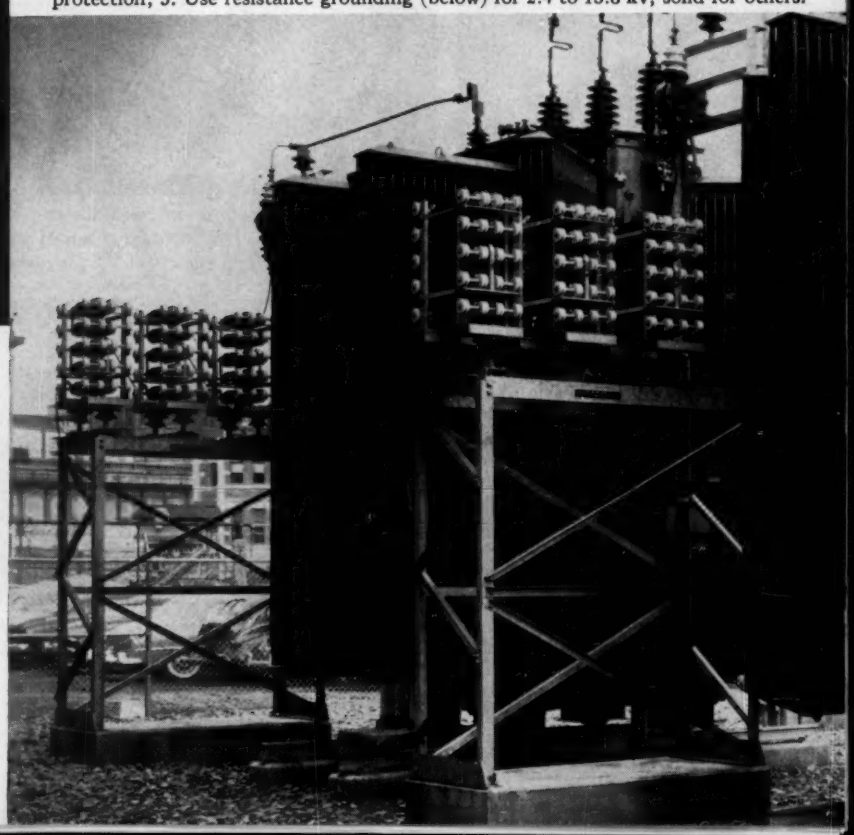
VOLTAGE REGULATION at main transformer can be accomplished with automatic load-tap-changing equipment if incoming voltage varies too much.

VOLTAGE-SENSITIVE equipment can be served by Inductrols*, above, or voltage stabilizing transformers installed in critical feeders to limit variation to ±1%.

Point 4 GROUND SYSTEM NEUTRAL

. . . to help isolate faults quickly, protect against overvoltages

FIVE GROUNDING RULES: 1. Ground neutral at each voltage level; 2. Ground neutral only at power sources; 3. Use three over-current devices or fuses—one on each phase; 4. Usually only two overload running relays are satisfactory for motor protection; 5. Use resistance grounding (below) for 2.4 to 13.8 kv, solid for others.



Trend to grounding system neutrals cuts operating, maintenance costs, protects equipment from prolonged exposure to excessive voltages due to faults. When a ground fault occurs it is immediately isolated, eliminating long searches for faulted equipment. Grounding improves service reliability by eliminating multiple faults caused by restriking grounds that build up huge voltages capable of shutting down entire plant.

*General Electric induction voltage regulators

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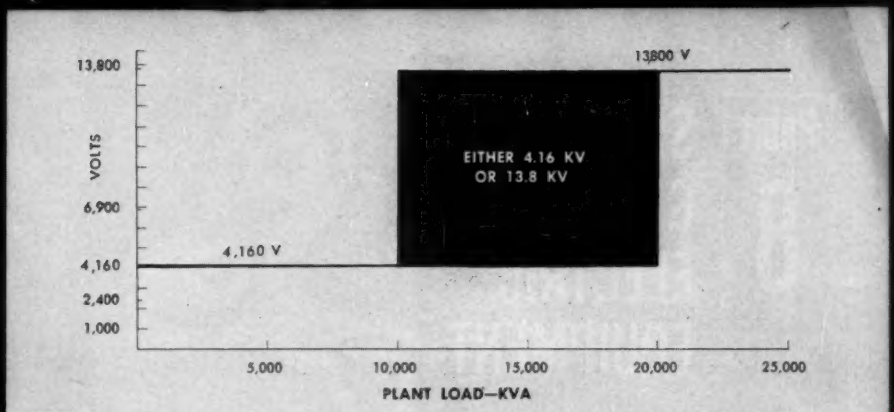
Point 5 SELECT HIGHER VOLTAGES

. . . to lower distribution costs, facilitate expansion



Select higher voltages for primary system and secondary distribution in new or expanded plants. Within limits, as distribution voltage goes up, conductor and circuit breaker costs drop.

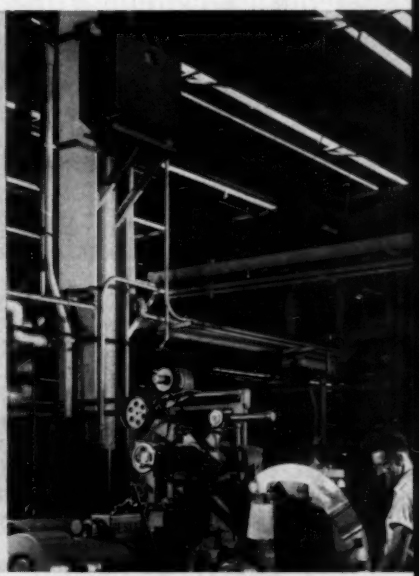
STUDIES SHOW 4.16 or 13.8 kv primary voltages will suffice for most plants. Remember plants grow—select high enough voltage now to serve larger loads of future; 4.16 might be more economical today, but 13.8 may be best in ten years. For secondary systems 480 v is usually best. It costs up to 35 percent less than 240-v system.

Point 6 COMBINE LIGHT AND POWER

. . . to save copper and dollars

Here again, higher voltage means lower distribution costs. 277-v fluorescent lighting served from line-to-neutral voltages of 480Y/277-v system provides top economy for general area illumination.

LEAST EXPENSIVE and most widely adaptable light and power design uses 480Y/277-volt system with 277-volt lighting. Power and lighting is supplied from same substation. Electricity is distributed at economical 480 volts. Some 120- or 240-volt power is always needed. It is most efficiently and economically provided by installing an economical dry-type transformer in that load area. Versatile General Electric Type D transformer is shown at right serving auxiliary equipment while machine runs on 480 volts and general area lights on 277 volts.



Point 7 USE MODERN CONDUCTORS

. . . for power distribution flexibility, economy

Modern conductors are specially designed to give fast, easy installation, provide flexibility for rearrangement of production facilities, create high feeder reliability.

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33 PERCENT SMALLER than equal-rated cable in conduit, General Electric interlocked armor cable bends easily around obstructions, has almost 100 percent relocation value.

FLEXIBILITY of machine arrangement is assured with Flex-a-Power* plug-in busway. Runs can be ceiling or floor supported, have outlets every 12 in.

*Reg. Trade Mark of General Electric Co.

Turn Page for Point 8 of program

Point 8 SPECIFY GENERAL ELECTRIC EQUIPMENT

. . . and these engineering services will be available to help protect your system investment

Not only do you receive top-quality equipment when you specify "G.E.", but General Electric's vast engineering resources also make valuable services available in six ways.

1. APPLICATION ENGINEERING assistance from industry-wide authorities like Don Beeman and Harold Kaufman, shown above, (l-r), helps you and your consultants select and design the most efficient power distribution system. It helps you put the 8-point program to work in your plant.

2. ANALYTICAL ENGINEERING employs engineering experience and electronic system analyzers to save valuable design time.

3. PRODUCT DEVELOPMENT laboratories design, test new equipment under tomorrow's conditions to meet future increased demands.

4. FIELD-SERVICE ENGINEERING helps supervise installation, expedite start-up of major electric equipment in customer's plant.

5. MAINTENANCE SERVICE from 51 Service Shops will repair and uprate old equipment, help establish productive maintenance, furnish emergency service.

6. PROJECT CO-ORDINATION means on-time engineering, shipment, installation of electric equipment from early planning through start-up.

G-E EQUIPMENT AND SERVICE CAN WORK FOR YOU. Your General Electric Apparatus Sales Representative can obtain any or all of the power distribution equipment illustrated and the services listed above. Contact him for assistance in implementing the G-E 8-point Power Distribution Program. Send coupon below for more information. General Electric Co., Section 680-2, Schenectady 5, N. Y.

Engineered Industrial Power Distribution Systems

GENERAL ELECTRIC

FOR MORE COMPLETE DEVELOPMENT OF THIS 8-POINT PROGRAM MAIL TODAY TO START NEW POWER DISTRIBUTION LIBRARY

Publications giving more detailed information and complete references on each of the points covered in this advertisement are currently being prepared. Bulletins covering Points 1 and 2 are completed and the remainder will be available soon. Use this coupon now to start your General Electric Power Distribution Library.

GENERAL ELECTRIC CO.
SECTION 680-2
SCHENECTADY 5, N. Y.

Please send bulletins—

☐ "How to Plan Load Center Power Distribution Systems,"

☐ "How to Provide IC for Power Distribution System Protection."

☐ Also, please send me subsequent bulletins of the library as they are published.

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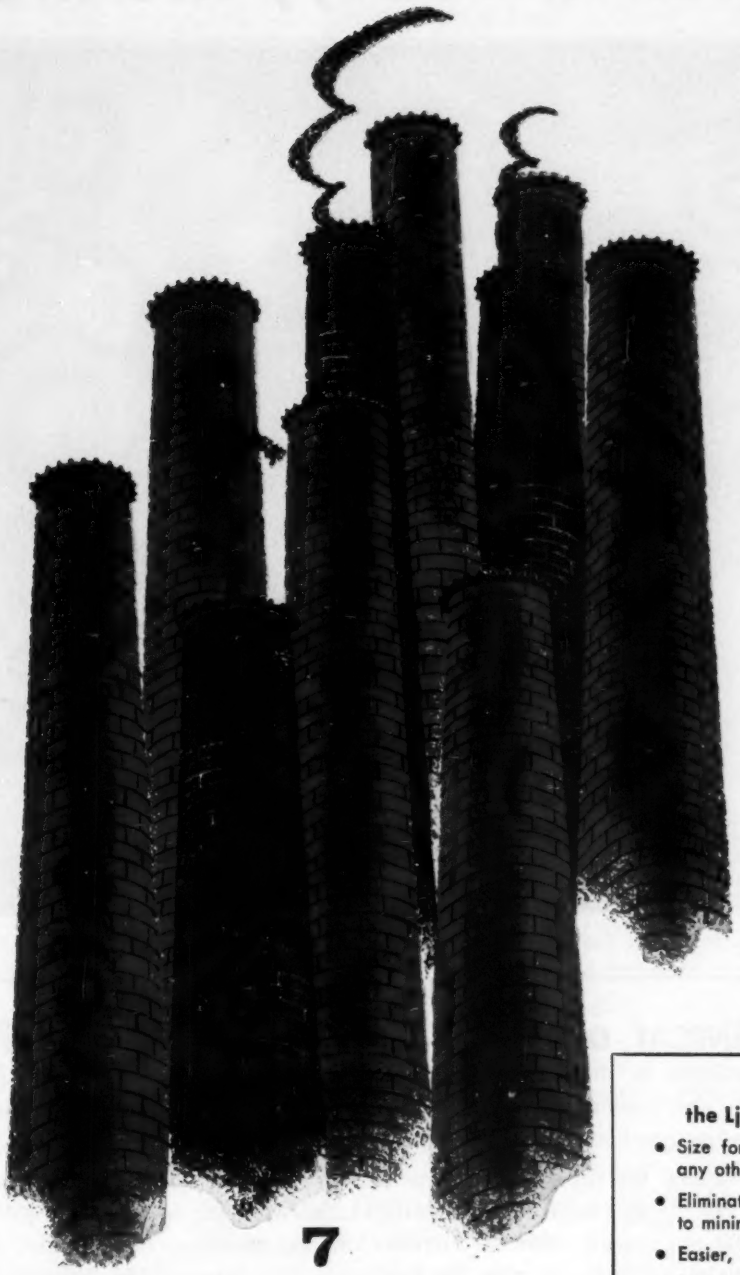
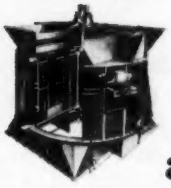
CITY..... STATE.....



Advantages of the Ljungstrom Air Preheater

- Size for size, recovers more heat than any other type.
- Eliminates cold spots . . . keeps corrosion to minimum.
- Easier, faster to clean and maintain.
- Requires far less supporting steel and is quickly erected.

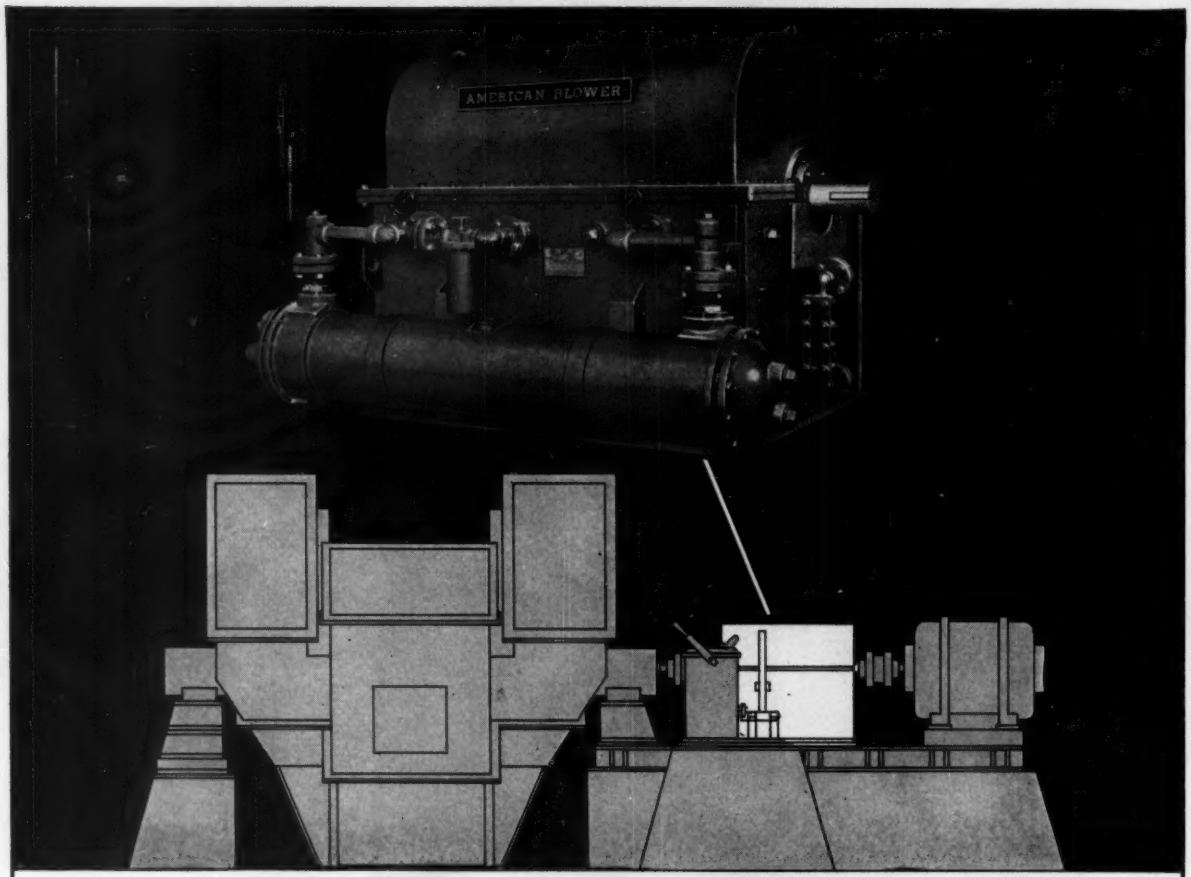


7 out of 10. . . air preheater installations are Ljungstrom®

MAXIMUM HEAT RECOVERY is one important reason. As a general rule, a height of one inch of the heating surface used in a Ljungstrom Air Preheater will recover about as much heat as one foot of length of the standard surface of conventional type air preheaters. For the interesting full story, send for a free copy of our 38-page manual.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

The tougher the duty, the more

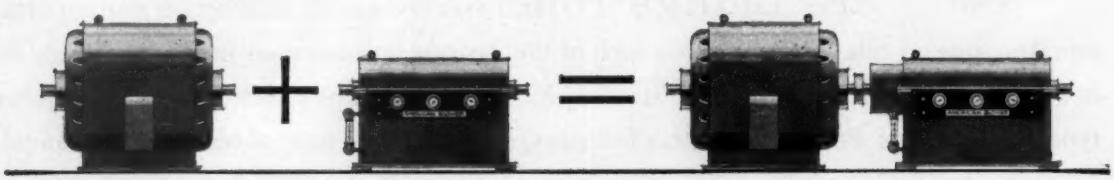


Mechanical Draft Fan Gýrol Fluid Drive Motor

LARGER MECHANICAL DRAFT FANS — Gýrol Fluid Drive gives you the kind of accurate, efficient control of mechanical draft that results in important power savings, longer equipment life. The reason: Fluid Drive's infinitely adjustable speed control, which enables each fan to operate at its optimum design or selection point.

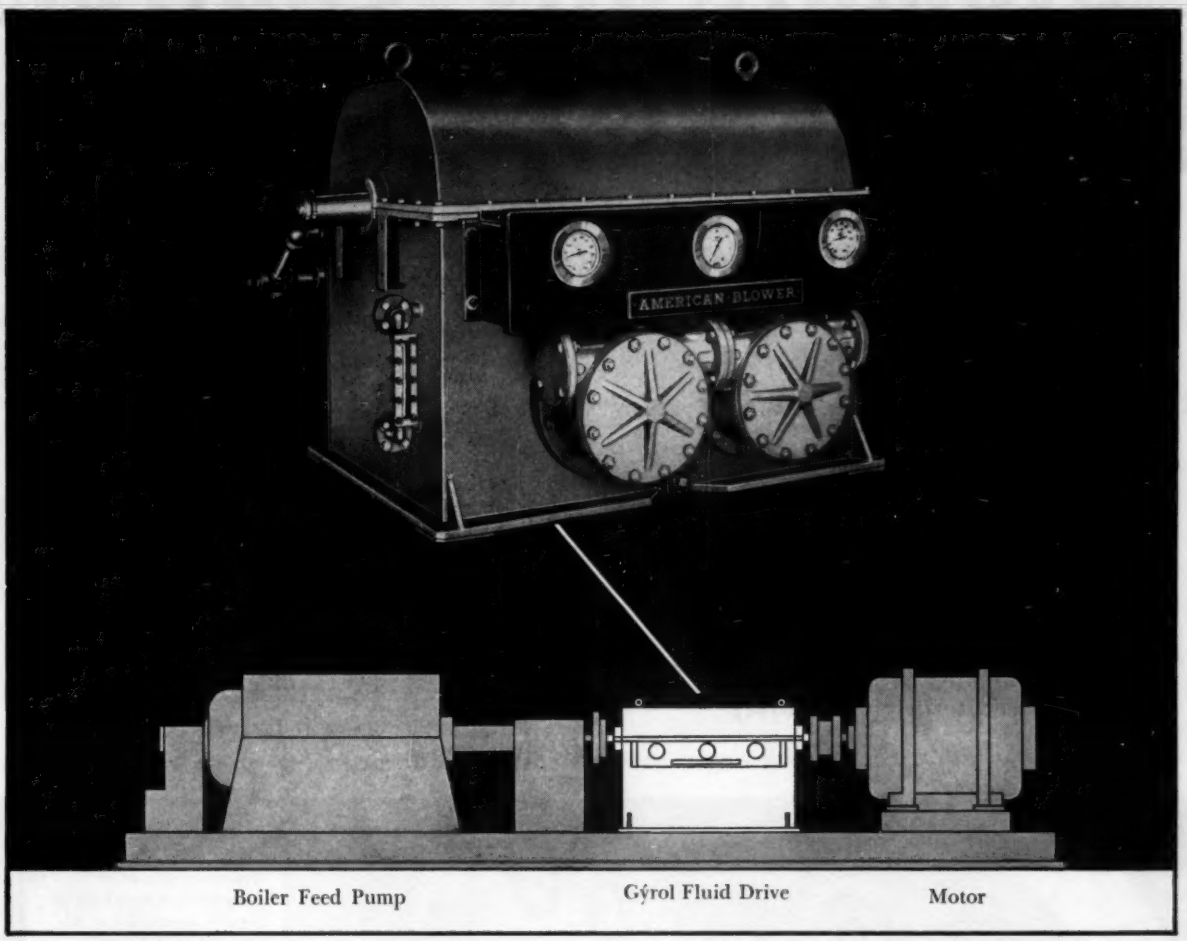
This adjustable-speed feature saves horsepower, gives good, stable volume and pressure control over the operating range . . . simplifies motor-starting equipment . . . reduces damaging high- and long-duration inrush currents on the motors . . . provides no-load starting of high WR^2s that exist in the new, high-volume, high-pressure fan wheels.

What's more, it prolongs life of fan bearings; reduces fly-ash abrasion on fan wheel, fan scroll, inlet boxes, and breeching connections. When you add to these advantages the reduction in noise level, it becomes increasingly clear that the tougher the duty, the more you need Gýrol Fluid Drive for control of mechanical draft.



Rugged constant-speed induction motor American Blower Gýrol Fluid Drive Smooth, adjustable-speed control

you need Gýrol® Fluid Drive



Boiler Feed Pump | Gýrol Fluid Drive | Motor

LARGER BOILER FEED PUMPS — As larger boiler feed pumps are built, there is a greater need for higher efficiencies and more accurate control. That's why more and more consulting and utility engineers are recommending Gýrol Fluid Drive.

You see, Gýrol Fluid Drive offers adjustable-speed pump control that saves power over the entire operating range by eliminating wasteful throttling. Then, too, Fluid Drive reduces wear on bearings and other vital parts by operating the pump at speeds that fit boiler demands. Paralleling of pumps is simplified. And emergency changeover from operating to standby pump is fast and foolproof—there's no need for boiler shutdown.

If your plant expansion calls for boiler feed pump control, it will pay you to talk to an American Blower engineer. He can show you where Gýrol Fluid Drive can save power, cut costs, give you a more efficient operation. Contact our nearest branch office, or write us direct. American Blower Corporation, Detroit 32, Michigan. In Canada: Canadian Sirocco Company, Ltd., Windsor, Ontario.

AMERICAN BLOWER

Division of American-Standard

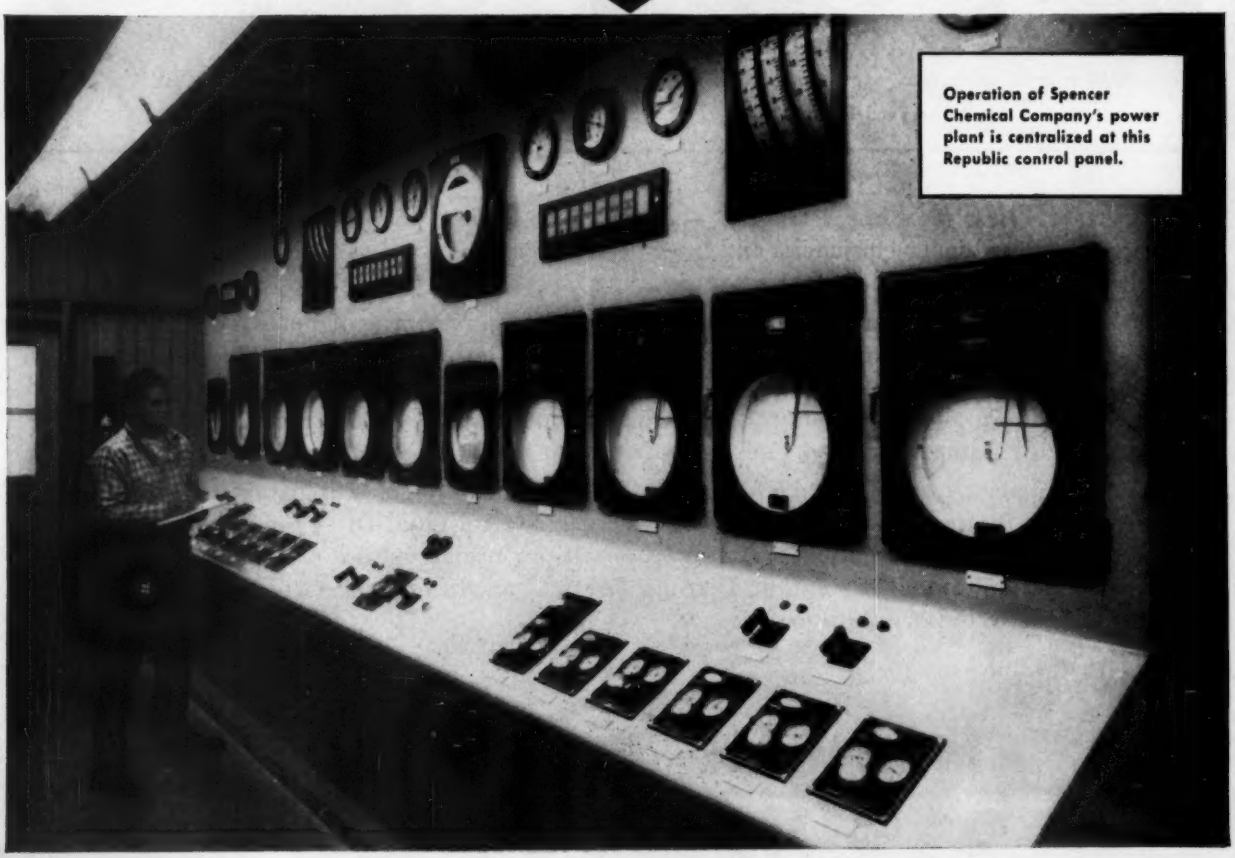
Automatically Controls Outdoor Steam Plant

FOR FAST LOAD CHANGES

REPUBLIC Combustion Control System at New Texas Chemical Plant Automatically Prevents Flame-Outs and Over-Firing on Wide Load Swings, Enables Boilers to Meet Sudden Steam Demands Smoothly and Safely

Extremely large and fast load changes make combustion efficiency only part of the combustion control job at Spencer Chemical Company's new Orange Texas polyethylene plant. The control system operates two gas fired 60,000 lbs. per hour boilers in the plant for fast response to load changes without over-firing or losing ignition on wide load swings.

To prevent over-firing when there is a sudden demand for more steam, a gas



Operation of Spencer Chemical Company's power plant is centralized at this Republic control panel.

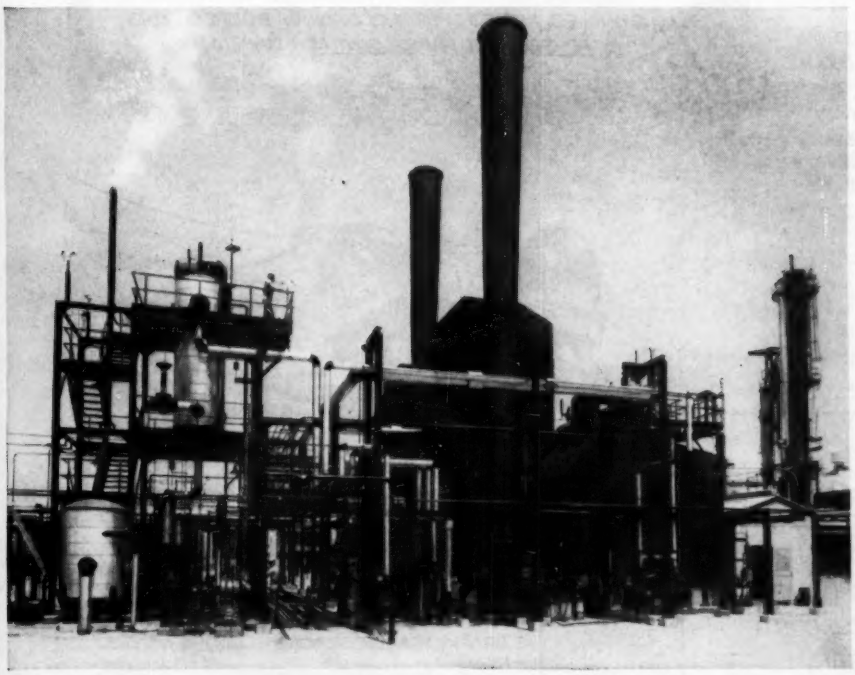
safety regulator keeps the fuel valve in step as draft fans increase speed. By compensating for the unequal speed of response of the two boiler auxiliaries, the control system maintains proper conditions *even while loads are changing.* If steam demand falls below minimum steam conditions, a minimum gas pressure is maintained automatically at the burners, regardless of the number in service, to prevent flame-outs. In addition to safer operation, these features also mean continuous combustion efficiency for extra fuel savings.

When your problem is combustion control—for a small power plant or a central station—it will pay you to contact Republic. At your service is an experienced engineering staff that can design the control system that exactly meets your needs—specialized as they may be. This combination of expert design and modern Republic equipment can assure you of dependable, efficient control of your power plant.

REPUBLIC
Automatic COMBUSTION CONTROLS
(pneumatic or electronic)

- ★ **FOR ALL SIZES AND TYPES OF BOILERS**
- ★ **FOR ALL LOAD CONDITIONS**
- ★ **FOR ALL METHODS OF FUEL FIRING**
- ★ **FOR ANY ARRANGEMENT OF DRAFT**

Write for details



THE ENTIRE POWER PLANT,

except for the control panel is outdoors. Panel board is housed in sheet metal building at right. The two 60,000 lbs. per hour gas fired boilers, operating at 415 psi and 750°F., furnish steam to compressors used in converting ethylene gas into polyethylene. This is new miracle plastic that is used for products ranging from "squeeze" bottles to electrical insulation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

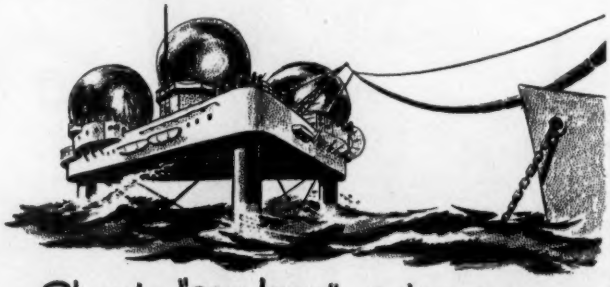
POWER POINTERS

5,000 Miles

OF MONEL SEAMLESS TUBING!

A NEW COLD-DRAW SECTION OF INCO'S HUNTINGTON WORKS IS CAPABLE OF TURNING OUT 5,000 MILES OF SEAMLESS MONEL* TUBING A YEAR. MORE THAN ENOUGH TO GO THE FULL LENGTH OF THE AMAZON RIVER! THE 85-FOOT LENGTHS ENABLE ENGINEERS TO TAKE ADVANTAGE OF GREATER HEATING AREA IN FEEDWATER HEATER TUBE BUNDLES, AND TO EFFECT ECONOMIES BY SPECIFYING LONGER HEATERS OF SMALLER DIAMETER!

CON EDISON'S NEW ASTORIA STATION DRAWS HIGHLY CORROSIVE, SALTY COOLING WATER FROM THE EAST RIVER. TO PREVENT SHAFT FAILURE FROM CORROSION ON THE FOUR 68,500 GPM PUMPS, CON EDISON ENGINEERS SPECIFIED "K" MONEL* AGE-HARDENABLE NICKEL-COPPER ALLOY SHAFTS.



Sturdy "sea legs" under a Man-Made Island!

SHEATHED IN MONEL, THE LEGS OF OFFSHORE RADAR PLATFORMS ARE PROTECTED FROM DANGEROUS CORROSION IN THE VICINITY OF THE WATERLINE. MONEL RESISTS SALT WATER...SALT AIR...SALT SPRAY. A NATURAL CHOICE FOR HANDLING BRACKISH AND CORROSIVE COOLING WATERS.

HAVE YOU A METAL PROBLEM?

THEN FIND OUT MORE ABOUT MONEL. HOW IT CAN HELP YOU EXTEND EQUIPMENT LIFE... REDUCE MAINTENANCE COST. WRITE FOR BULLETIN,

"ENGINEERING PROPERTIES OF MONEL"

IT'S FREE ON REQUEST.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys** *Registered Trademark

More POWER for you . . . with MONEL

6 ADVANTAGES OF A. P. GREEN PLASTIC AND CASTABLE REFRACTORIES IN WATERTUBE BOILERS

MONOLITHIC CONSTRUCTION

A monolithic refractory lining, properly installed, gives better combustion efficiency and longer, more trouble-free service than any other type lining.

ANCHORED FURNACE LININGS

A. P. Green "floating" anchors hold the refractory lining securely against the casing and permit free expansion and contraction movement.

AIR-COOLED—SECTIONALLY SUPPORTED WALLS

A. P. Green offers a simple design for air-cooled walls—no special tile are required. Provision for recovery of preheated air can be made. Alloy supporting plates are available for use in extremely high walls, over stoker arches, and burner openings, permitting replacement of any section without disturbing the adjacent areas.

LESS HEAT LOSS THROUGH WALLS

The low thermal conductivity of A. P. Green plastic and refractory castables means less heat loss through the walls, greater efficiency, and more protection for the outer casing of the boiler.

LOWER INSTALLATION COSTS

Special shapes are eliminated . . . expensive, time-consuming brick cutting is not necessary. With proper supervision, the installation can be done by average labor.

EXPERIENCED DISTRIBUTORS—QUALITY WORKMANSHIP

An authorized A. P. Green distributor, trained in refractory problems, is close to your job to give you the kind of quality workmanship your refractory job demands. He is backed by the engineering staff of the A. P. Green Fire Brick Company.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas

In Canada: **A. P. GREEN FIRE BRICK COMPANY, LTD.**
Toronto 15, Ontario

Distributors in the Principal Cities of the World

Send for this free booklet

PLEASE SEND ME A COPY OF YOUR BOOKLET ENTITLED
"A. P. Green Refactory Linings for Watertube Boilers."

NAME_____

COMPANY NAME_____

ADDRESS_____

CITY_____ STATE_____

A. P. GREEN FIRE BRICK CO., MEXICO, MISSOURI, U. S. A.

Building Water Treatment Systems *is a man-size job!*

Having been in the water conditioning business for nearly fifty years, we know that *every* water treatment job is a challenge. In this business, you can't send a boy to do a man's work.

Since 1908, Elgin has been designing, building and installing water conditioning equipment for thousands of purposes in hundreds of industries, institutions, municipalities and commercial establishments. Naturally, during that time, we've built up a backlog of experience and water engineering skill second to none. As a result, the name *Elgin* has become synonymous with superiority in the field of water conditioning — whether softening, dealkalizing, demineralizing, deaeration, degasification, chemical treatment.

Elgin makes it a policy to meet *every* water treatment problem with concentrated attention. You can feel sure — when you bring your problem to us — that all the experience and knowledge at our command will be at your disposal. Talk over your water treatment problems with your Elgin representative. Or write us direct. We *can* help you!

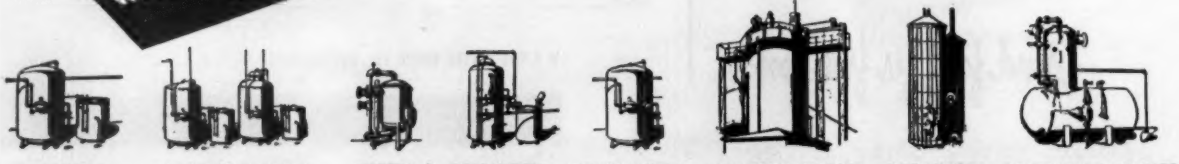
ELGIN WATER CONDITIONING

ELGIN SOFTENER CORPORATION

130 No. Grove Avenue, Elgin, Illinois

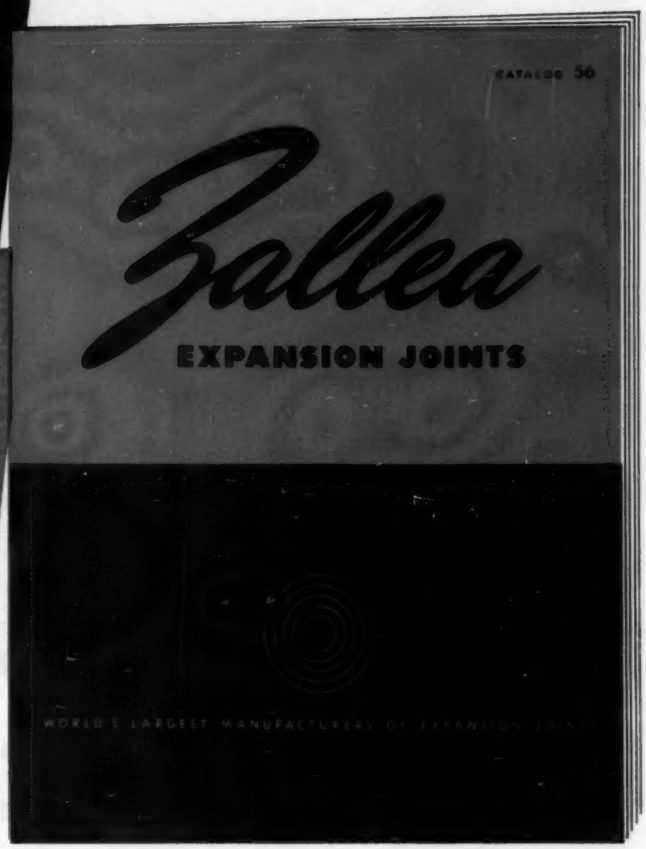
Representatives in Principal Cities

In Canada: G. F. Sterne & Sons Ltd., Brantford



SOFTENERS | ION EXCHANGERS | FILTERS | DEIONIZERS | DEALKALIZERS | LIME COAGULATORS | DEGASITORS | DEAERATING HEATERS

NEW NEW NEW



72-PAGE EXPANSION JOINT MANUAL

More than just another catalog. It is actually a complete and authoritative text that covers every phase of expansion joint design, construction, selection and installation.

Separate sections deal with the various types of Zallea Expansion Joints for absorbing axial, lateral and rotational movements.

New Zallea HyPTor Expansion Joints for high pressure applications are introduced.

Over 40 pages of tables and engineering data simplify expansion joint selection.

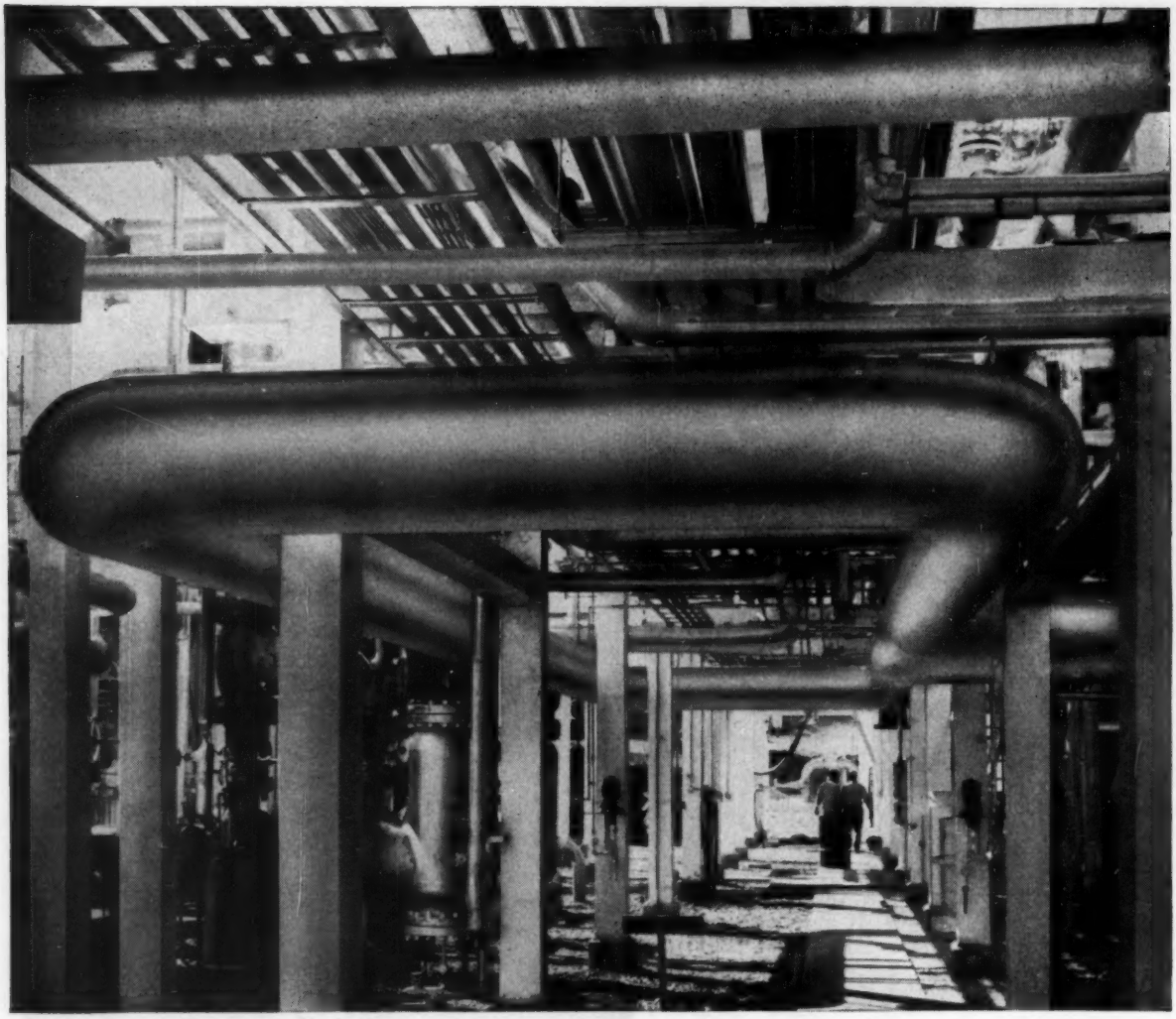
This manual is a must for any engineer having problems that involve the movement of piping due to temperature changes.

Write today, on your company letterhead, for your copy of Catalog 56.

Zallea expansion joints

ZALLEA BROTHERS, 814 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints



Less heat loss at joints with single-layer Unibestos® Pipe Insulation

Tests prove that Unibestos single-layer pipe insulation actually provides greater protection than other nonfibrous *double-layer* insulations which cost more to install. Unibestos is made of Amosite—the long-fibered African asbestos. These fibers interlock with one another to prevent heat loss at horizontal and longitudinal joints.

While most insulating materials show a pronounced shrinkage at high temperatures, Unibestos has no measurable shrinkage at 1200°F. It will not powder, pulp or wash off, even under heavy moisture conditions, and when dry, Unibestos resumes its original thermal and physical characteristics.

EASY to install . . . easy to remove.

Unibestos can be cut, mitered and handled easily. The fabrication of insulation for tees, valves, flange covers, etc., is a fast, low-cost operation. Because of its unusual strength and durability Unibestos can be removed and replaced with little or no loss of material.

STANDARD PRODUCTION SIZES

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½″ through 24″, in standard thicknesses through 5″. Unibestos Block Insulation is made in 6″, 12″, 18″ or 36″ widths and in thicknesses from 1″ through 3″ in ½″ increments.

For complete information, write for descriptive Bulletin 109C

UNARCO

UNION ASBESTOS & RUBBER COMPANY
1111 West Perry Street • Bloomington, Illinois

Inside story:

Valves may look alike on the surface. Their performance is another story. And the inside story of Powell Valves is that *every* Powell Valve has *Performance Verified.*

X-ray and gamma ray inspection—examining the very structure of the metal itself—are two of the many ways that Powell can make absolutely certain that Powell Valves will give *dependable* flow control.

Every part of every valve must pass rigid inspection. As a final step in manufacture, every Powell Valve is subjected to *an actual line test.* Because of Powell's pains-taking quality control, valve repair is cut to the minimum and plant shut down through valve failure is substantially reduced. Records from refineries, power and industrial plants the world over prove it.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

PERFORMANCE PV VERIFIED

FIG. 19003 WE—900-Pound Steel Pressure Seal Gate Valve.

FIG. 11365 WE—Steel Pressure Seal Horizontal Lift Check Valve for 1500 Pounds W.S.P.

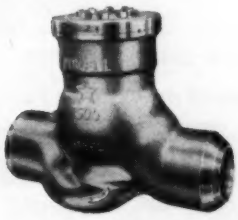
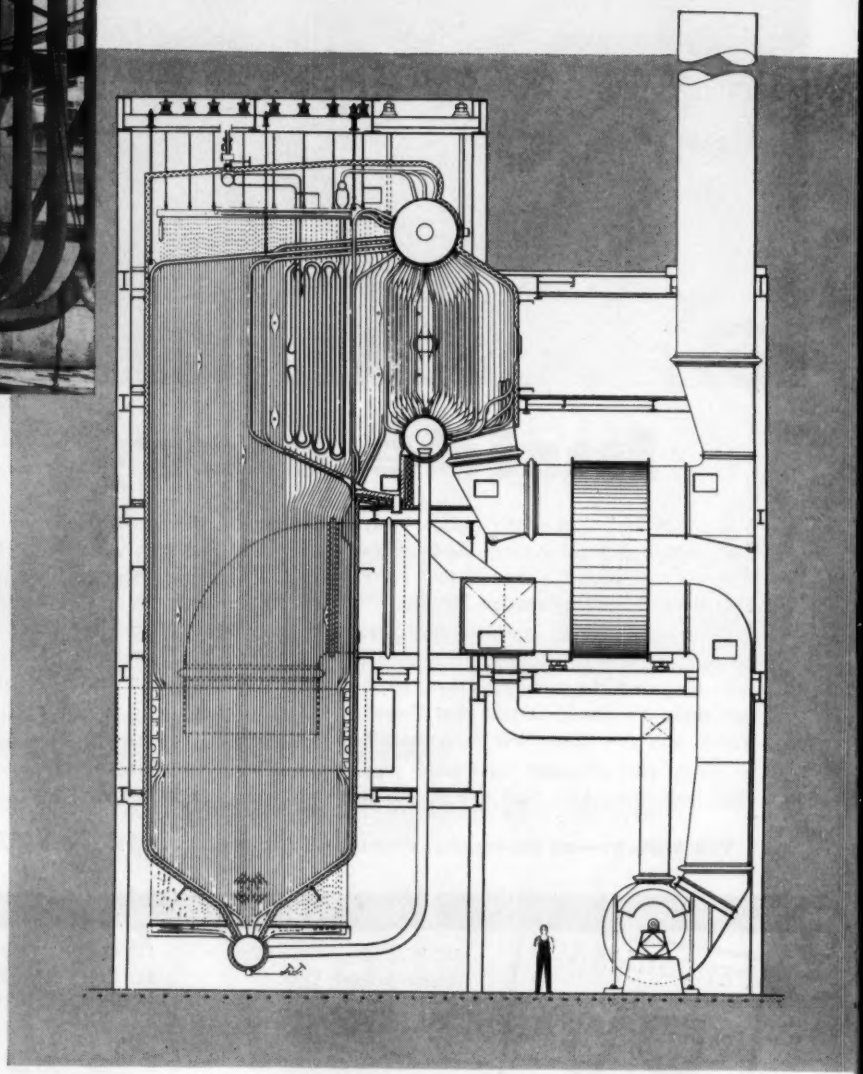


FIG. 3031 WE—Steel Globe Valve for 300 Pounds W.S.P.

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

More Kilowatt
with REPUBLIC



SPECIFICATIONS

CAPACITY
350,000 lbs. of steam per hour

DESIGN PRESSURE
450 psi

OPERATING PRESSURE
400 psi

STEAM TEMPERATURE
700°F.

HEATING SURFACE (Boiler)
12,550 sq. ft.

HEATING SURFACE (Water Walls)
7,530 sq. ft.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

Hours for Joplin Area

ELECTRUNITE Boiler Tubes

Joplin, a progressive city investing millions in redevelopment, has been called Missouri's fastest growing industrial center.

To serve the area's rapidly increasing electrical requirements, the Empire District Electric Company recently completed a new steam generator at its nearby Riverton Power Station located at Riverton, Kansas. This boiler, with a capacity of 350,000 lbs. of steam per hour, is designed to operate at 400 PSI and 700°F, and is part of a modernization program replacing eighteen smaller boilers in the same plant.

The new boiler, designed and installed by Combustion Engineering, Inc., New York, includes nearly 85 tons of tubing, of which thousands of feet were supplied by Republic.

Good performance on previous jobs makes Republic ELECTRUNITE Boiler Tubing a popular choice with leading boiler manufacturers. They know they can count on complete dependability and maximum efficiency in every foot of tubing.

Republic makes sure of this in every step of manufacture. Foremost safeguard is the electric welding process which produces a precise, uniform wall thickness, assuring efficient, even heat transfer all around and throughout the length of each tube. Thin spots cannot occur. And each tube is hydrostatically or electrically tested in excess of code requirements.

Get all the facts on Republic ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubing from your local Republic Representative. Or check coupon for desired literature. Ask for Republic's handy wall chart entitled "Care and Maintenance of Boiler Tubing." It's a handy guide to protecting your boiler installation.

Uniform diameter and concentricity of Republic ELECTRUNITE Boiler Tubing is demonstrated here where several lengths of tubing are inserted in drum simultaneously. Uniform ductility of Republic steel permits smooth, accurate bends—plus full expansion roll-in.

Uniform wall thickness of ELECTRUNITE Boiler Tubing permits fast, easy welds with no danger of burn-throughs due to thin spots. And uniform roundness of each tube helps joining with no delays.

REPUBLIC STEEL CORPORATION
Dept. C-2279
3144 East 45th Street, Cleveland 27, Ohio

Please send:

- ☐ Illustrated booklet giving facts on ELECTRUNITE® Boiler Tubes
- ☐ 8-page brochure on Heat Exchanger Tubing ☐ carbon steel ☐ stainless steel
- ☐ Handy wall chart on care and maintenance of boiler tubes

Name_____ Title_____

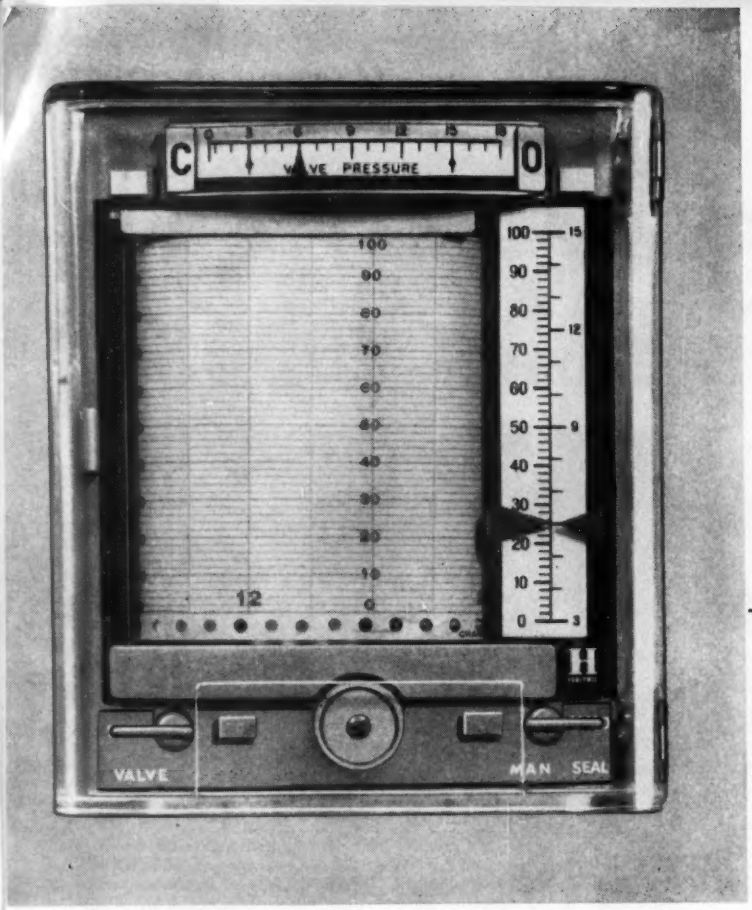
Company_____

Address_____

City_____ Zone____ State_____

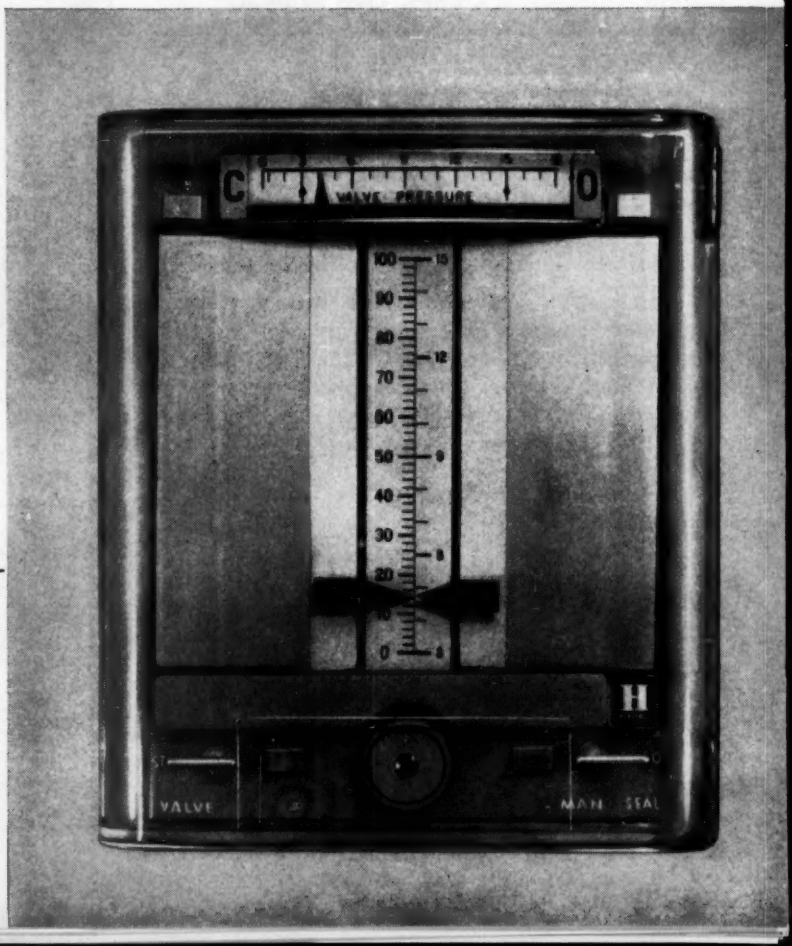
STEEL

and Steel Products



for simplest

Both the *Tel-O-Set* indicator and recorder have vertical indicating scales on which large, opposing pointers clearly show measured value and set point. The control knob and transfer switches are located near the bottom of the case, where they can be manipulated without the operator's hand obscuring the view of the pointer and scale.



● **REFERENCE DATA:**

Write for Bulletin 7202.

Design your instrumentation

installation, startup, service

-with *Tel-O-Set* instruments

The exclusive features designed into *Tel-O-Set* miniature instruments save you time, trouble and money . . . from the instant these instruments are installed on your control panels.

Easy installation. The indicating and recording chassis is a complete assembly that can be supplied separate from the case. Since the case contains the valve pressure gage and pressure regulator, you can install it in the panel, make complete piping connections . . . and then insert the instrument chassis later, at startup.

Foolproof startup. Because it can be shipped separately, the chassis is protected against dirt and damage until it is ready to begin service. Air lines can be checked, control valves stroked and final inspection made *before* the chassis and controller are installed.

Serviced in seconds. Down-time for instrument maintenance is eliminated, for a complete chassis can be replaced in just a few seconds. There is no loss of control during replacement . . . no disturbance to electrical connections. To adjust zero and span, or to inspect parts, you can partly withdraw the chassis from the case, without interrupting operation.

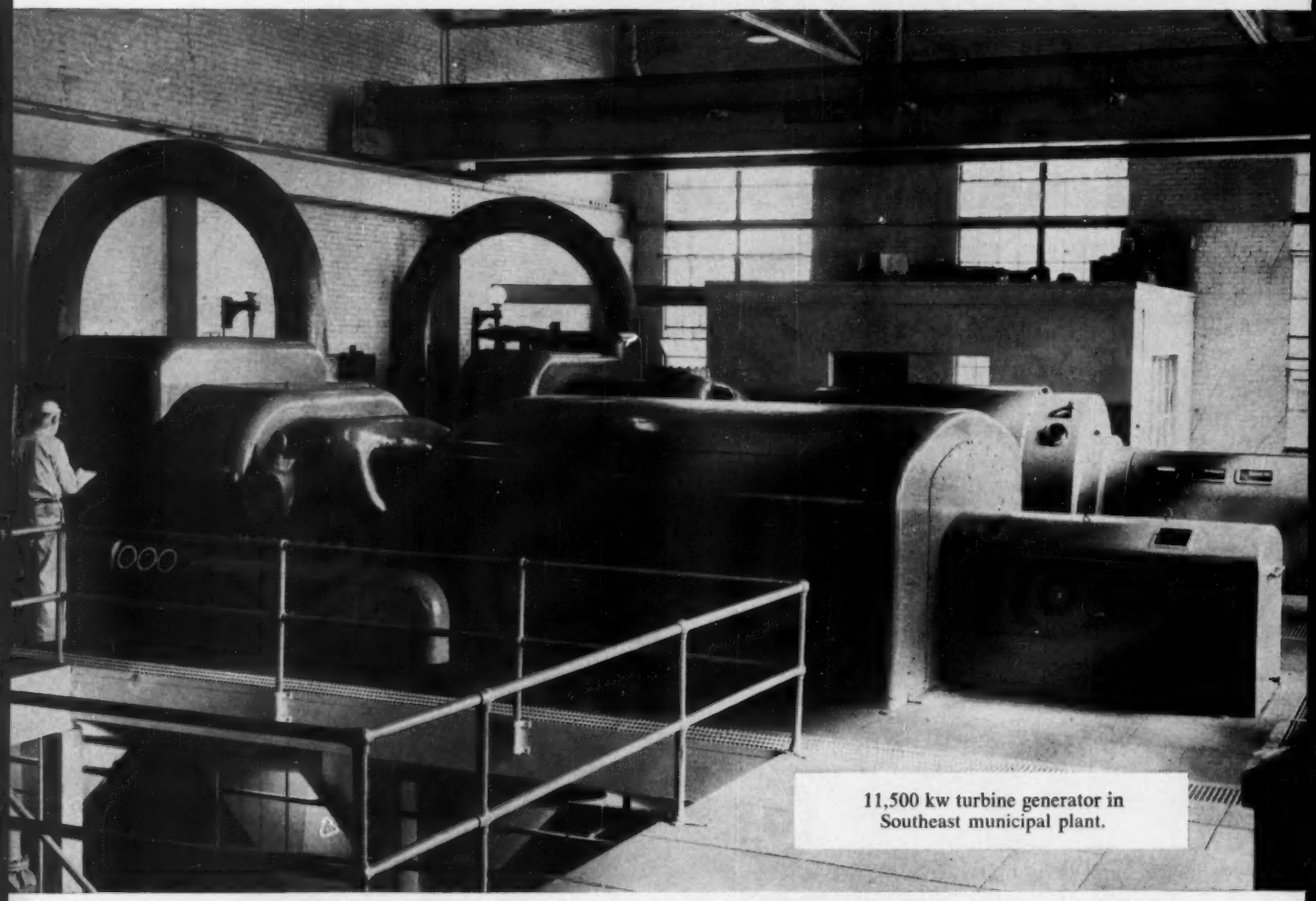
Tel-O-Set instruments can handle a broad range of temperature, pressure, flow and liquid level applications. They work with any type of pneumatic force-balance controller. They are sensitive and accurate . . . have true linear calibration . . . respond instantly to changes in measured variables. For a discussion of how you can use them profitably, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls



11,500 kw turbine generator in Southeast municipal plant.

Specializing in turbine generators up to 15,000 kw gives better quality control and product service

Take priority, for example. Because Worthington is not involved with building the huge central station turbine generators, they give A-1 priority to the design and manufacture of industrial and municipal units.

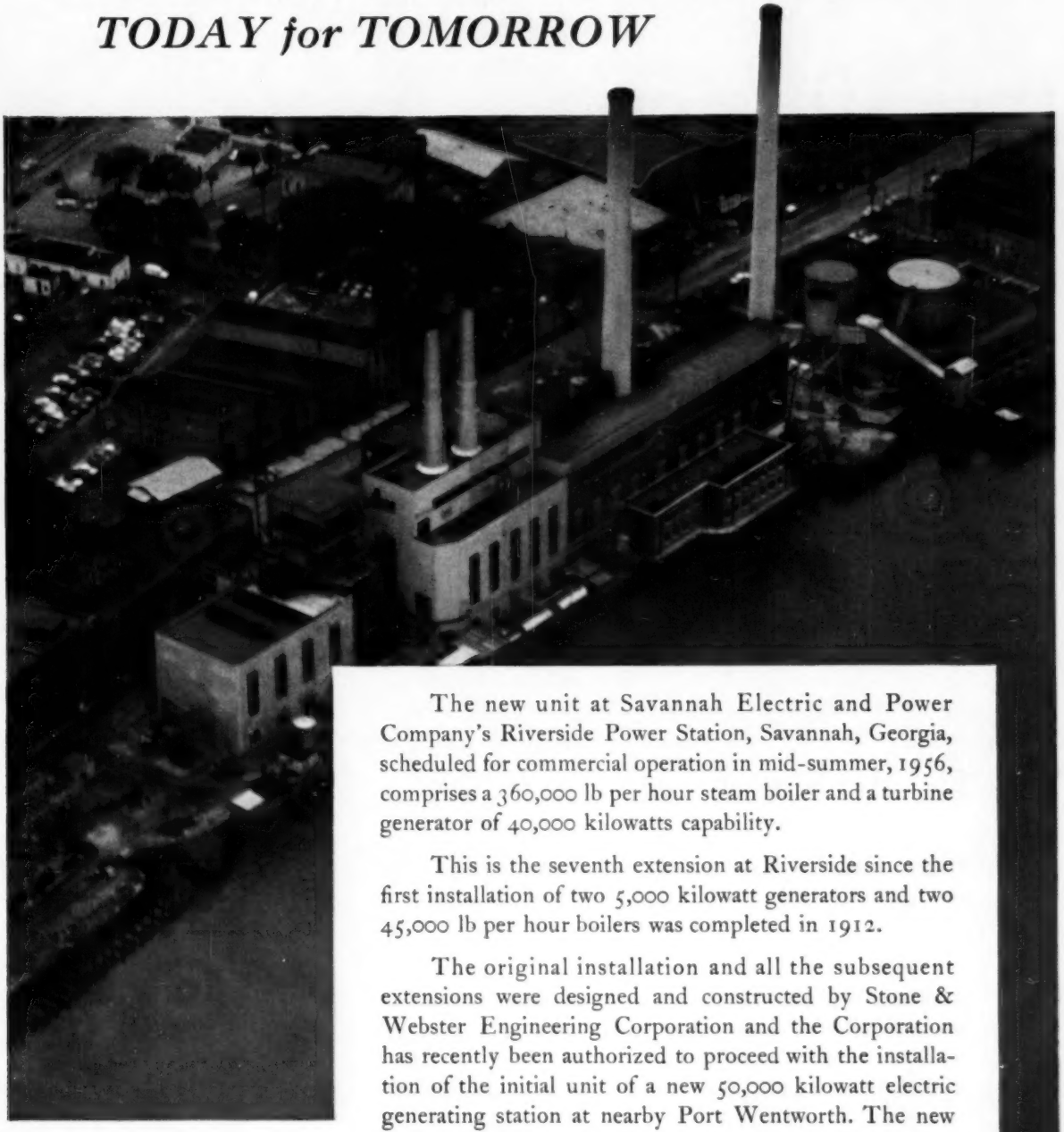
Every Worthington turbine generator receives the personal attention of top engineering and manufacturing personnel. Skilled craftsmen, with years of experience in the manufacture of turbine generators, take pride in their job of building reliability into every part. They take the time and trouble to take care of the little things that mean so much to dependable operation. Their attention to detail is reflected in such things as the dials which are recessed and mounted at an angle for easy reading. And before it is allowed to leave the factory, every unit is completely assembled and meticulously tested.

When considering a turbine generator installation up to 15,000 kw, call on the *specialists* in the field. Get in touch with your nearest Worthington District Office or write for Bulletin 1960C. Address Section T63, Worthington Corporation, Harrison, N. J.

T-6-3

WORTHINGTON

SAVANNAH ELECTRIC PREPARES *TODAY for TOMORROW*



The new unit at Savannah Electric and Power Company's Riverside Power Station, Savannah, Georgia, scheduled for commercial operation in mid-summer, 1956, comprises a 360,000 lb per hour steam boiler and a turbine generator of 40,000 kilowatts capability.

This is the seventh extension at Riverside since the first installation of two 5,000 kilowatt generators and two 45,000 lb per hour boilers was completed in 1912.

The original installation and all the subsequent extensions were designed and constructed by Stone & Webster Engineering Corporation and the Corporation has recently been authorized to proceed with the installation of the initial unit of a new 50,000 kilowatt electric generating station at nearby Port Wentworth. The new station is part of the Company's program for keeping ahead of the area's rapidly increasing industrial and residential power requirements.

Eighty per cent of the Engineering Corporation's construction work since 1889 has been in the nature of "repeat orders" from previous clients.

Write or call for our new booklet, "How Stone & Webster Engineering Corporation Can Help You".

STONE & WEBSTER ENGINEERING CORPORATION

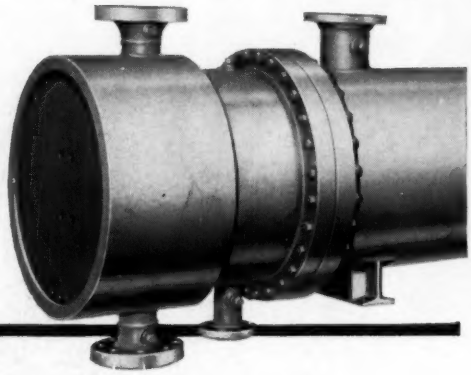
A SUBSIDIARY of STONE & WEBSTER, INC.

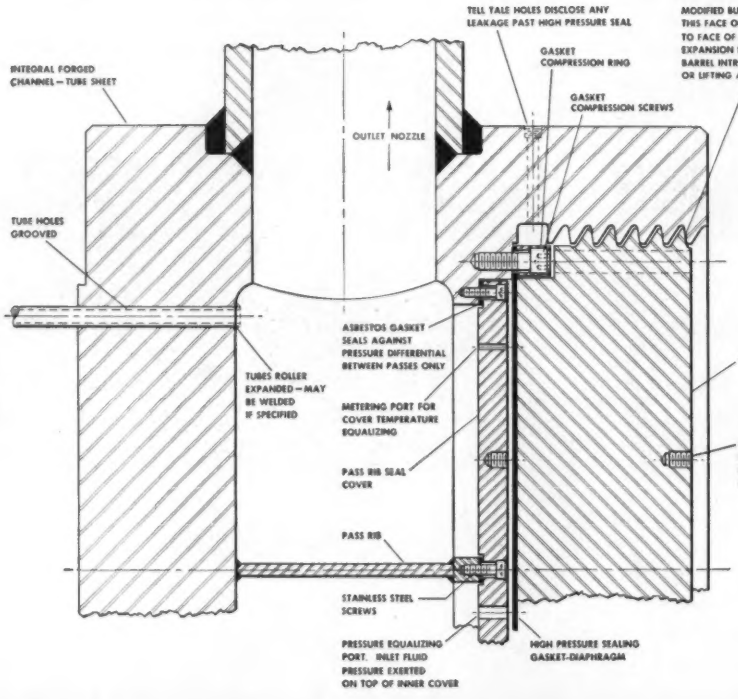
New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

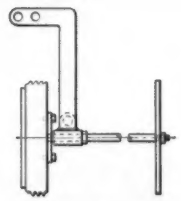
INSIDE FACTS

on the simplicity, safety and operating advantages of the exclusive Ross High Pressure Closure Design*

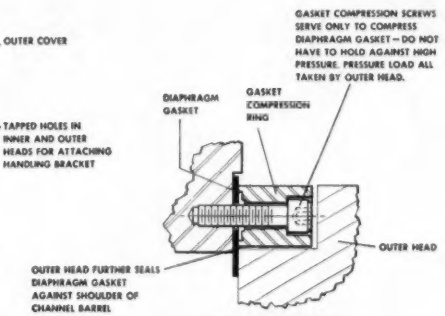
- Simpler design.
- Fewer parts to handle.
- High pressure seal unaffected by hydrostatic loads.
- Greater safety factor.
- Sudden load fluctuations no problem.
- Outer cover cannot corrode and bind . . . easily removed.
- Easily opened for inspection.




TELL TALE HOLES DISCLOSE ANY LEAKAGE PAST HIGH PRESSURE SEAL
MODIFIED BUTTRESS THREAD. THIS FACE OF THREAD PARALLEL TO FACE OF HEAD. DIFFERENTIAL EXPANSION BETWEEN HEAD AND BARREL INTRODUCES NO WEDGING OR LIFTING ACTION IN HEAD.
GASKET COMPRESSION RING
GASKET COMPRESSION SCREWS
INTEGRAL FORGED CHANNEL – TUBE SHEET
OUTLET NOZZLE
TUBE HOLES GROOVED
ASBESTOS GASKET SEALS AGAINST PRESSURE DIFFERENTIAL BETWEEN PASSES ONLY
TUBES ROLLER EXPANDED – MAY BE WELDED IF SPECIFIED
METERING PORT FOR COVER TEMPERATURE EQUALIZING
PASS RIB SEAL COVER
PASS RIB
STAINLESS STEEL SCREWS
PRESSURE EQUALIZING PORT. INLET FLUID PRESSURE EXERTED ON TOP OF INNER COVER
HIGH PRESSURE SEALING GASKET-DIAPHRAGM
OUTER COVER
TAPPED HOLES IN INNER AND OUTER HEADS FOR ATTACHING HANDLING BRACKET



TYPICAL COVER HANDLING BRACKET FOR HORIZONTAL UNIT


GASKET COMPRESSION SCREWS SERVE ONLY TO COMPRESS DIAPHRAGM GASKET – DO NOT HAVE TO HOLD AGAINST HIGH PRESSURE. PRESSURE LOAD ALL TAKEN BY OUTER HEAD.
DIAPHRAGM GASKET
GASKET COMPRESSION RING
OUTER HEAD
OUTER HEAD FURTHER SEALS DIAPHRAGM GASKET AGAINST SHOULDER OF CHANNEL BARREL

DETAIL OF GASKET COMPRESSION RING FACING

NOW FOR ALL THE DETAILS,

request new Bulletin 5.6K1, mailed immediately. Write Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

ROSS

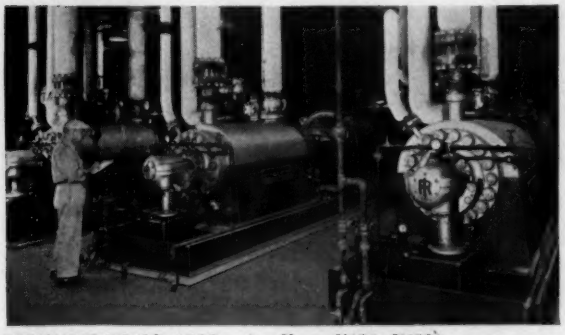
ROSS HEAT EXCHANGER PRODUCTS

*for feedwater heaters and other high pressure, high temperature exchangers

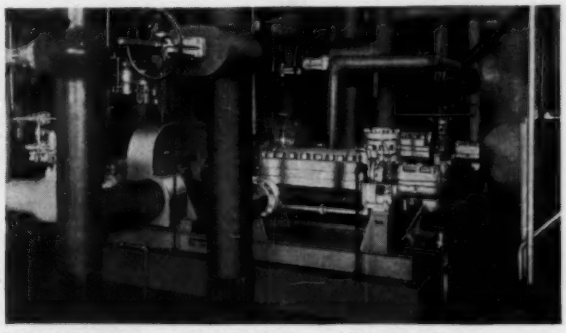
BOILER FEED PUMPS GIVE DEPENDABLE PERFORMANCE

at all pressures, capacities, temperatures.

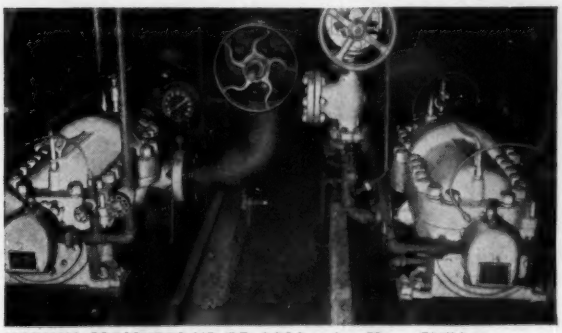
Typical I-R installations indicate wide range of use in central stations and industrial plants



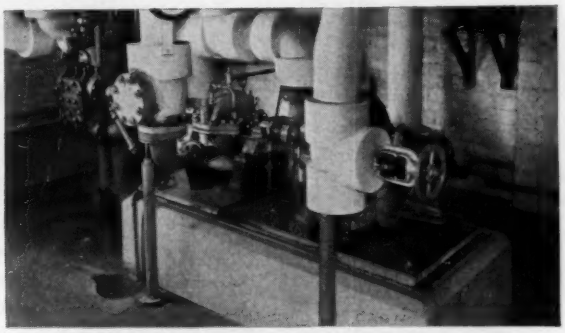
PRESSURES UP TO 6500 psi.—Class CHTA-CHTB: These multi-stage, cylindrical "double-case pumps meet the most exacting needs of the highest-pressure boilers in modern central station service. Each of the above pumps handle 1100 gpm of feedwater at 2395 psi.



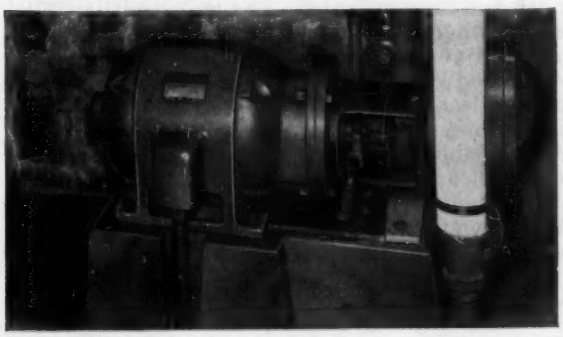
PRESSURES UP TO 1200 psi.—Class HMTA-HMTB: A complete line of multi-stage centrifugal pumps featuring a symmetrical, horizontally-split casing, and a simplified unit-type rotor assembly. The pumps illustrated are on boiler feed service in a large textile mill.



MEDIUM PRESSURES UP TO 1000 psi.—Class CNTA: Symmetrical design with unit-type rotor gives CNTA pumps higher efficiency, easier maintenance, and attractive modern appearance. Installed in a large paper mill, the boiler feed pumps shown operate at 3560 rpm and deliver 180 gpm at 605 psi.



PRESSURES TO 450 psi.—Class GT: Dependability is designed into this line of two-stage, horizontally split pumps. Standard construction includes renewable wearing rings and water-cooled, ring-oiled bearings. Pump shown serves as a boiler feed unit in a large candy factory.



PRESSURES TO 250 psi. — Motorpumps: A complete line of space-saving centrifugal pumps, including both close-coupled and cradle-mounted types. Single , two-stage, and vertical four-stage models are available. Pump shown is handling boiler feed in a leather factory.

Ingersoll-Rand boiler feed pumps have many refinements in design and construction that add up to high operating efficiency. Skilled manufacture and painstaking factory inspections assure dependability built into every pump. Inherent simplicity and ruggedness mean easier and less maintenance—and trouble-free performance.

Whatever pressure or capacity you need, Ingersoll-Rand can supply a boiler feed pump for the job. I-R engineers will gladly help you select the pump that meets your needs.

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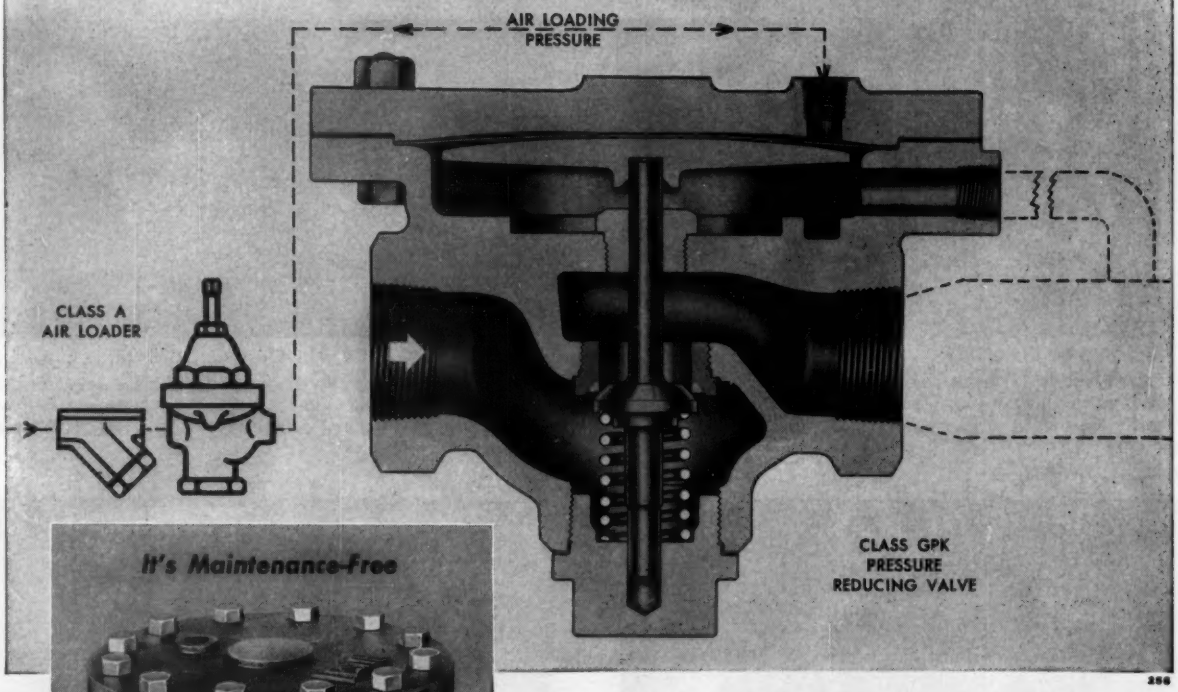
No maintenance inspection on this new valve until 1959!



You can just put this amazingly simple and compact Leslie Class GPK-A pressure reducing valve on the line and forget it for at least 3 years!

YES, AND THAT'S A *GUARANTEE* backed by a reputation for quality established in more than half a century of design, development and manufacture of regulators and controllers.

This amazing new, diaphragm operated, Leslie pressure reducing valve has *only two moving parts:* no seals; no stuffing boxes; no small, dirt-catching parts.

A simple air loader eliminates the conventional bulky loading spring and provides accurate diaphragm loading that gives pilot-type response. Yet, it is rugged and uncomplicated. The unit itself lends itself readily where remote adjustment is an advantage, too. And you pay no price premium for these advantages. You get Leslie quality for about the same initial cost as leading makes of ordinary regulators.

Suitable for any steam service up to 250 psi, 450°F, the unit is available in ½" to 2" sizes. It is ideal for intermittent service too, and is unaffected by dirty steam.

Your Leslie engineer can give you all the data on this amazing valve. You'll find him listed in your classified directory under "Valves" or "Regulators".

Send for YOUR copy of Bulletin 561 today.

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REGULATORS AND CONTROLLERS

LESLIE CO., 235 GRANT AVENUE, LYNDHURST, NEW JERSEY

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...Better Performance for Accumulators and Hydraulic Presses!

Ankorite Triple "U" Brand Leather Packing is an excellent flexible packing ring for oil and hydraulic press plungers, accumulators, Triplex pump plungers and hydraulic rams. Due to their construction, two rings of Triple "U" packings are used in replacing ordinary molded U leather or cup leathers.

Ankorite Triple "U" is immediately available in coil form in multiples of 10 feet or in continuous lengths up to 400 feet, and in sizes ½" to 1¼" in packing width.

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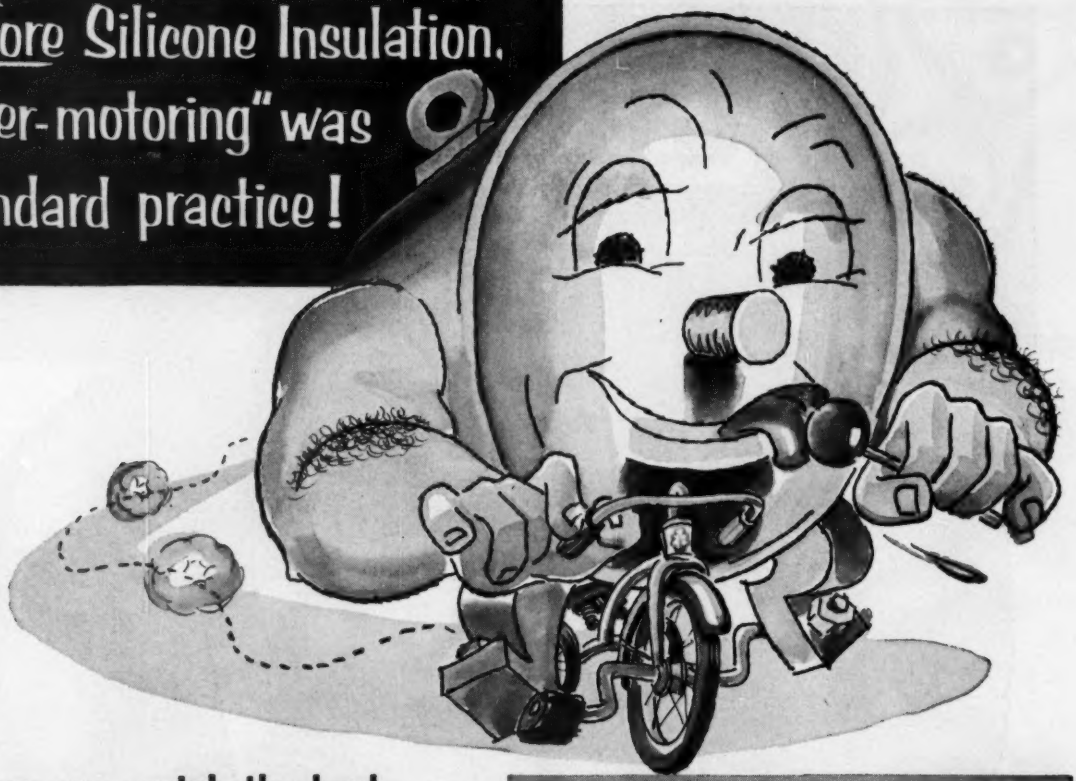

Now you can match the load . . . let silicones carry the overloads

Lazy motors cost money! Why continue to pay a fat premium for motors that make kid's play of their average work load? Today, you can save money by using *silicone insulated* motors rated to *match your average load*. Their built-in service factor of 25 to 50% will handle most intermittent overloads or loads that can't be matched in standard frame sizes.

Cut your capital investment and installation costs! Think of it—for every dollar dumped into *unused* motor capacity, you spend an extra $3 for starters, cable, transformer capacity and installation costs.

Enjoy more continuous production! You can depend on motors insulated with Dow Corning silicones to have maximum resistance to such motor killers as heat, moisture and corrosive atmospheres.

Remember, over-motoring is outmoded

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Please send me sources of supply for new Silicone (Class H) ☐ Motors ☐ Transformers

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Rolling up more evidence...

R. G. LeTourneau, Inc. of Longview, Texas, installs a silicone insulated d-c motor in each of the 24 electric wheels of the giant "Sno-Freighter." Silicone insulation is used to give maximum power per pound under tough operating conditions. The silicone insulated motors, located in tubular axles and connected through a gear train in the wheel hubs, demonstrate the advantages of placing the power unit close to the work . . . a basic principle made practical by the heat stability of Dow Corning silicone dielectrics.

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CANADA: Dow Corning Silicones Ltd., Toronto
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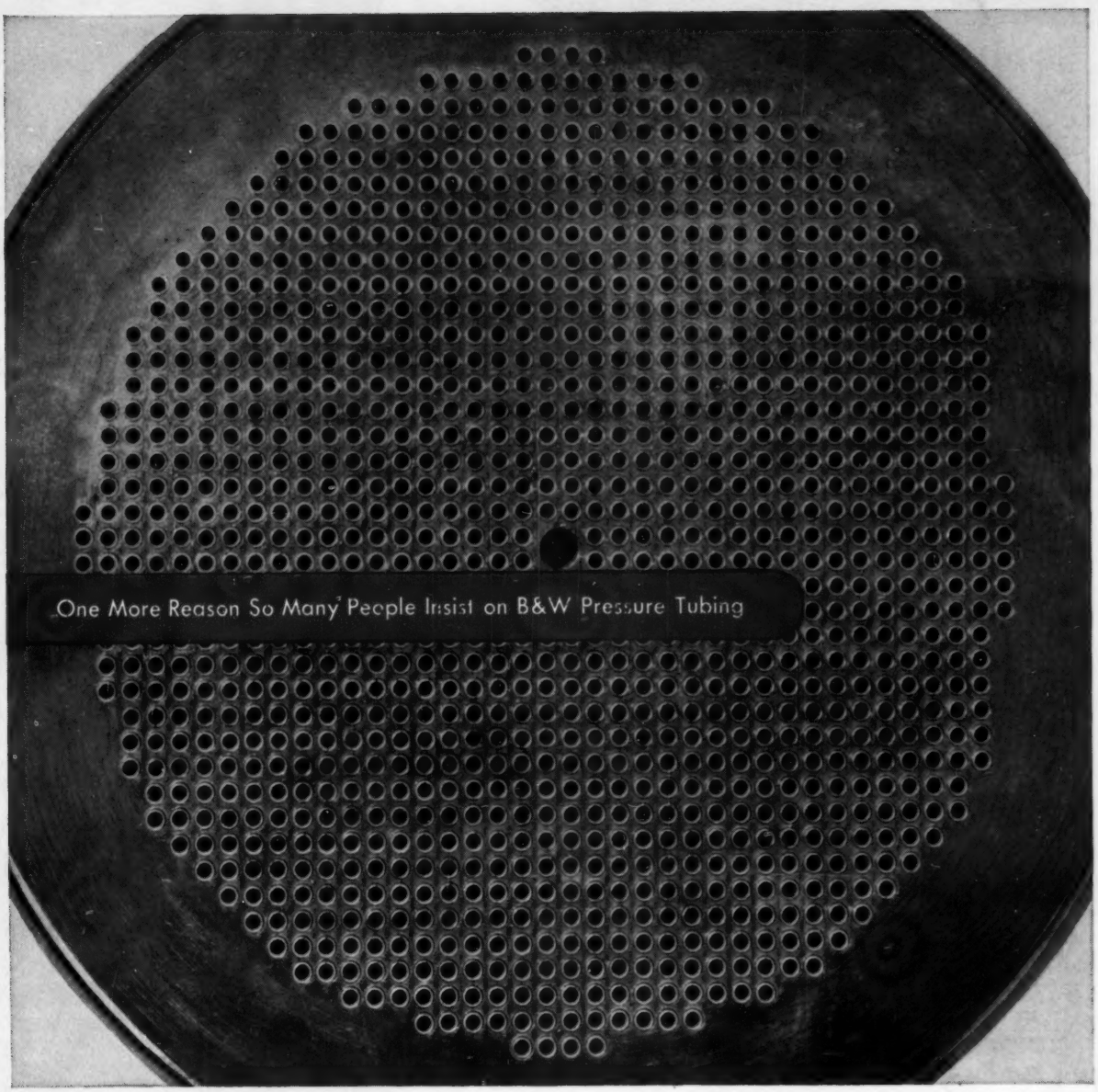

B&W TUBING UNIFORMITY – MULTIPLIED 1194 TIMES

If you had this many tubes to roll in, there would be no delay if you used B&W tubes.

For heat exchangers, for condensers, in fact for every pressure tubing application, you can rely on B&W tubing for uniform wall thickness, uniform ductility, tight joints, and low installation cost.

Always specify B&W pressure tubing. It meets all dimensional and mechanical requirements, and is available, in all commercial sizes, in a wide range of carbon, alloy and stainless grades. *Write for Technical Bulletin 329P.*

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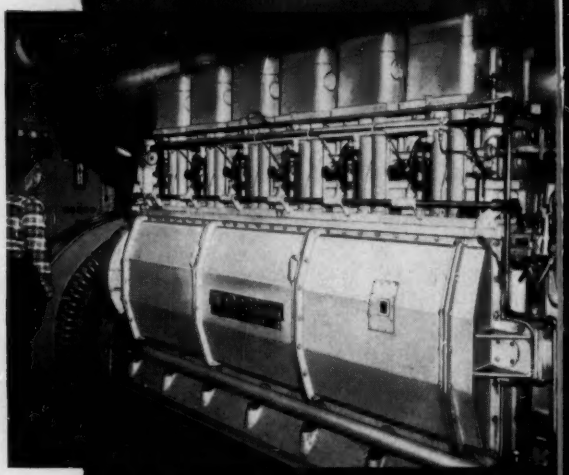
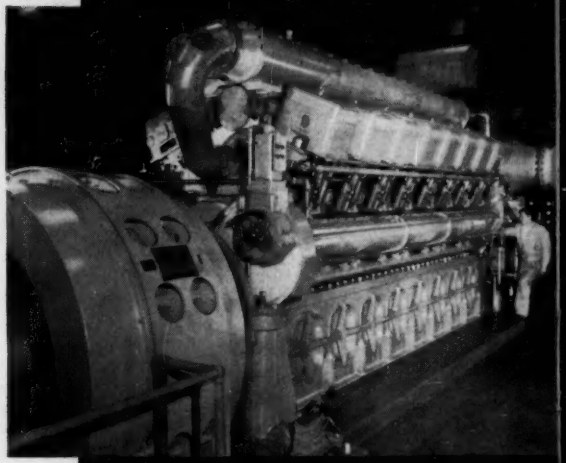
TA-5019(P)

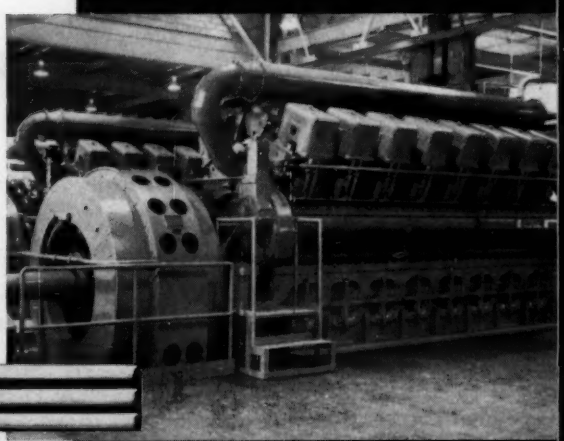
3 WAYS TO CUT POWER COSTS WITH NORDBERG ENGINES



1 ***For standby service*** . . . this 1200 hp, 840 kw Nordberg *Supairthermal®* Diesel Generator is serving a Midwestern Utility Company.



2 ***For peak load service*** . . . this is one of three Nordberg *Supairthermal* Diesel generator units, ranging from 1150 kw to 2285 kw, now serving a Southern Utility Company.



3 ***For boosting voltage*** . . . these are two 3500 hp, 2500 kw Nordberg Diesel Generator units serving an Eastern Utility Company.

These three typical installations show some of the ways that utilities are now utilizing Nordberg engines to increase the operating flexibility of their existing facilities and to add valuable standby protection on a financially sound, profitable basis.

Built in sizes from 10 to over 12,000 horsepower, including Diesel, Duafuel® and Spark-Ignition Gas types, Nordberg engines are easily installed, go on the line quickly and provide low cost power generation under all load conditions.

Let experienced Nordberg engineers help solve your specific power problem.
Write for further information.

NORDBERG MFG. CO., Milwaukee, Wisconsin

BUILDERS OF AMERICA'S LARGEST LINE OF HEAVY DUTY ENGINES . . . 10 to over 12,000 HORSEPOWER

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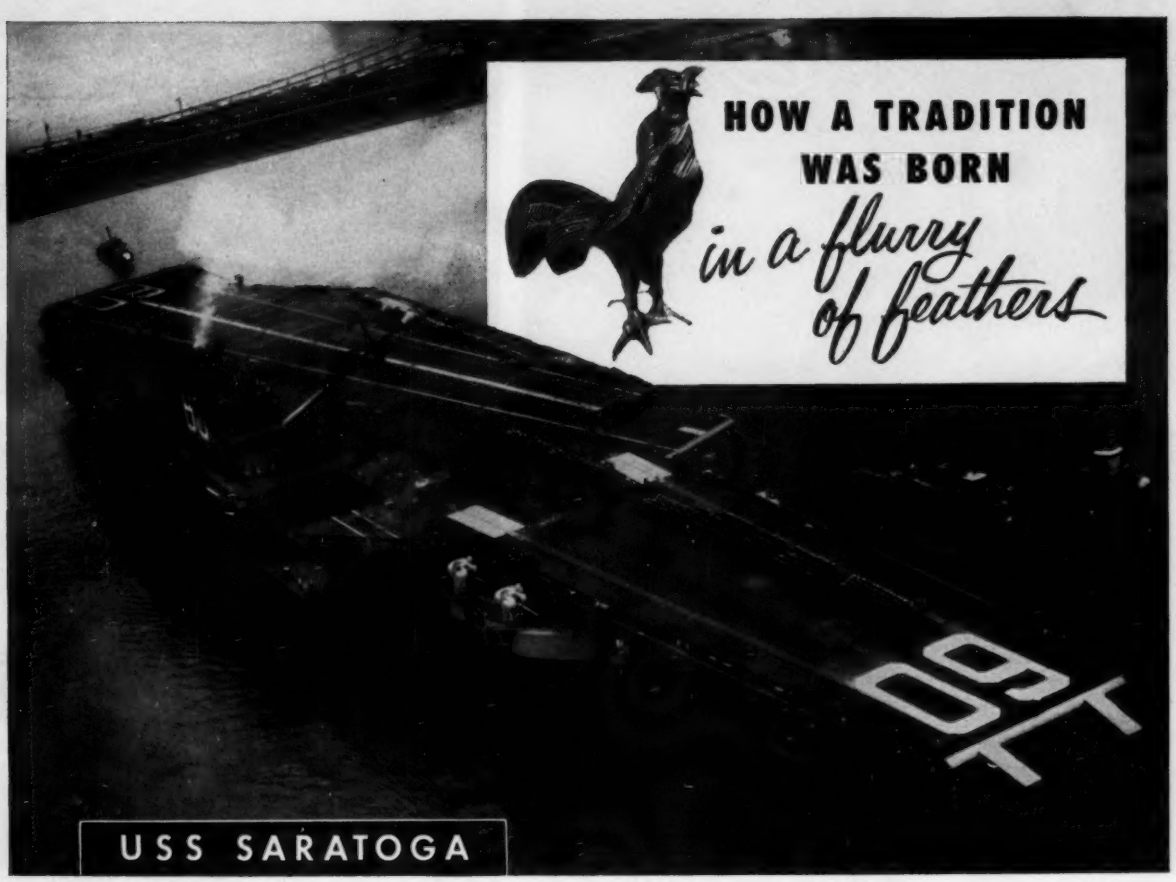
NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES



The symbol, and the spirit, of the fighting gamecock lives on with the commissioning of the powerful aircraft carrier, *USS Saratoga*.

The incident which gave birth to this 142 year old Navy tradition took place on the decks of the first *Saratoga* as she closed for action against four men-o'-war in 1812. In the opening minutes of the engagement an enemy ball landed on deck – crashing into a coop containing a gamecock brought aboard by a sailor.

With a flurry of feathers, the startled bird flew to the rail and, as if expressing his personal indignation, crowed lustily and defiantly. Taking this as an omen of good luck, the outnumbered and outgunned American ship entered the battle with new courage and completely won the day.

The Navy's newest aircraft carrier is the fourth ship to bear the name *Saratoga* and adopt its fighting symbol. As aboard its sister aircraft carriers, the USS Forrestal, USS Independence*, and USS Ranger*, Walworth Valves and Fittings are installed. We are proud of the many contributions that our products and engineering skills have made to these outstanding vessels.

Walworth products installed aboard these ships include Pressure-Seal Cast Steel Gate, Globe, and Angle Valves, Fabricated Cast Steel Manifold Valves, Cast Steel Y-Globe and Angle Valves, Bronze Gate, Globe, Angle, and Check Valves and thousands of Walworth pipe fittings including Walseal® Fittings, Flanges, and Unions.

*Now under construction.

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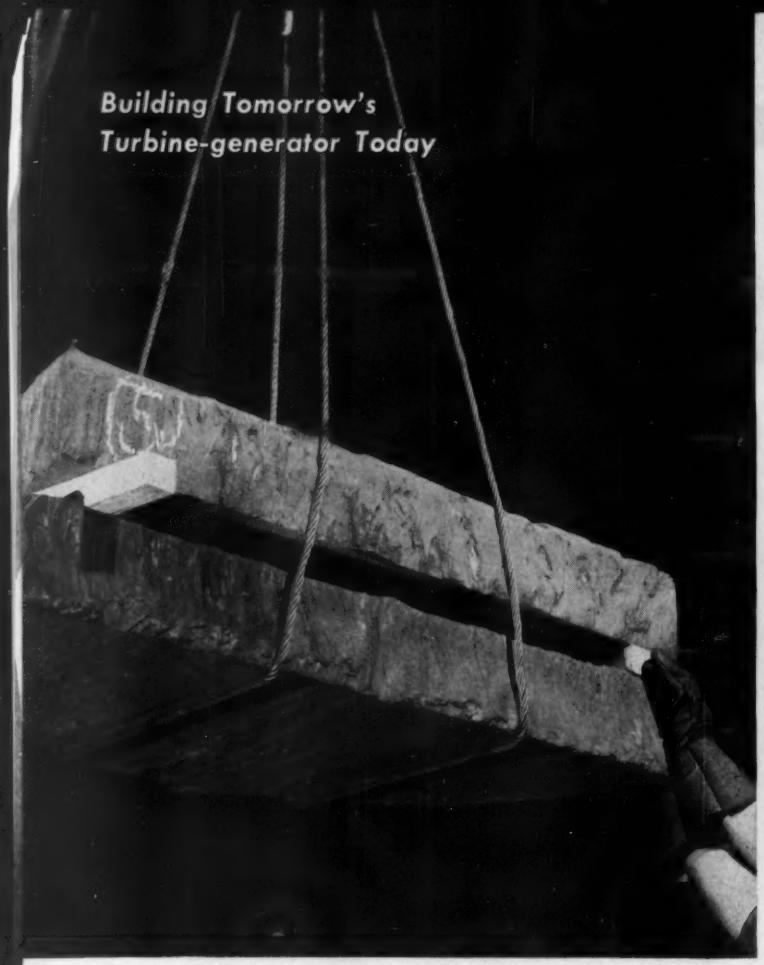
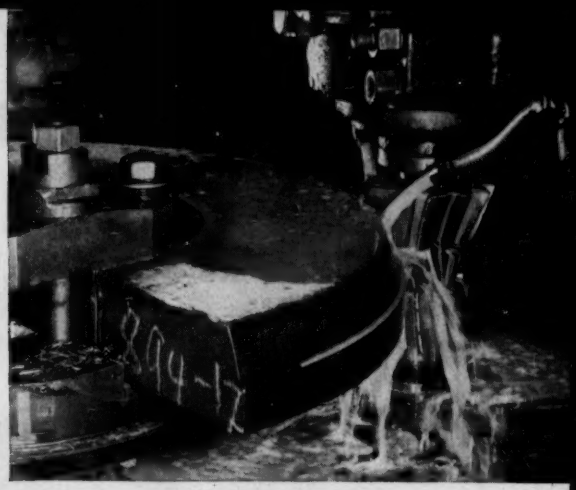
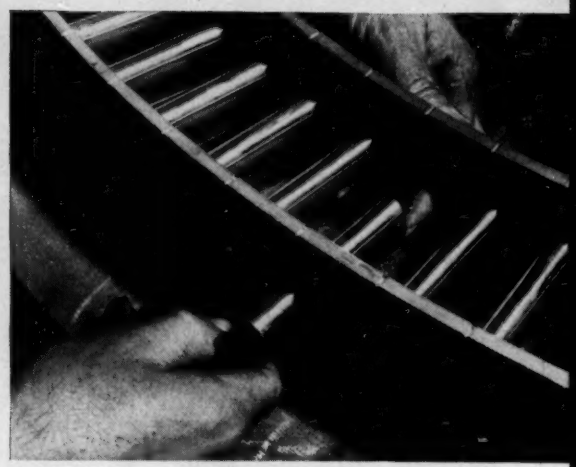
Turbine-generator Today







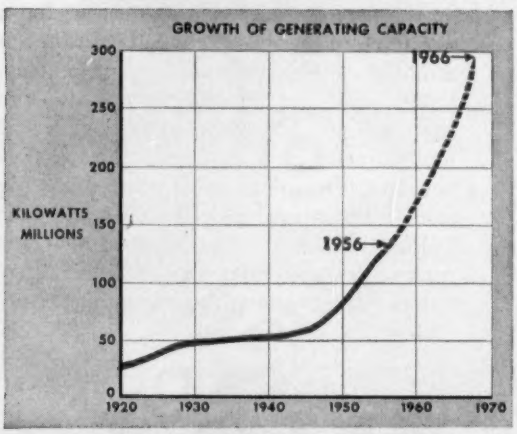
THE HIGH-PRESSURE END DIAPHRAGM WEBS are made from heavy alloy steel plates or castings. Some are ten inches thick and can withstand high pressure drops and maintain close clearances.

THE WEB is then carefully machined for welding (top). Nozzle partitions are machined from solid chrome-iron alloy and assembled in punched bands (bottom).

How General Electric builds sturdy nozzle-

GENERAL ELECTRIC MAINTAINS a continuing program of research on turbine diaphragms. This smoke tunnel provides a visual indication of how steam flow will follow new nozzle designs.

TO MEET TOMORROW'S EXPANDING LOADS



G.E. works with electric utilities and consulting engineers in these vital turbine-generator areas:

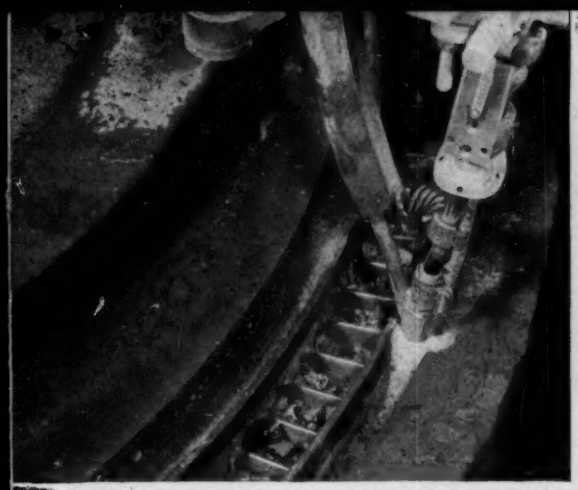
BASIC RESEARCH

APPLIED RESEARCH

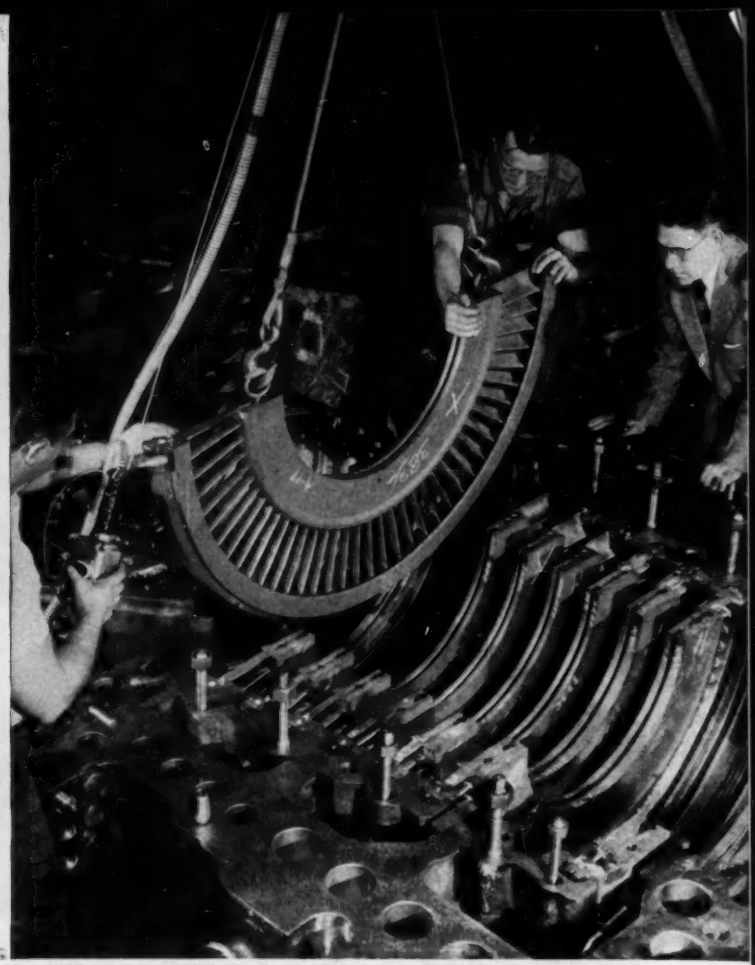
PRODUCT DEVELOPMENT; NOZZLE-DIAPHRAGMS

TESTING

MAINTENANCE



THIS NOZZLE assembly is welded to the web and outer ring (top). A finishing operation puts a high polish on the partitions for a smooth steam path (bottom).



DIAPHRAGM HALVES are lowered into the turbine shell. The rotor is then assembled and the upper shell containing the top half of the diaphragm is added to form a series of complete compartments.

diaphragms to reduce turbine maintenance

TOUGH CONSTRUCTION HELPS PROTECT STEAM PATH AGAINST DESTRUCTIVE FOREIGN MATERIALS

Internal damage to the steam path can be a costly and time consuming cause of turbine shutdown. Should large amounts of foreign material enter the steam path whole rows of buckets and partitions might be severely damaged. This could mean a long and costly outage.

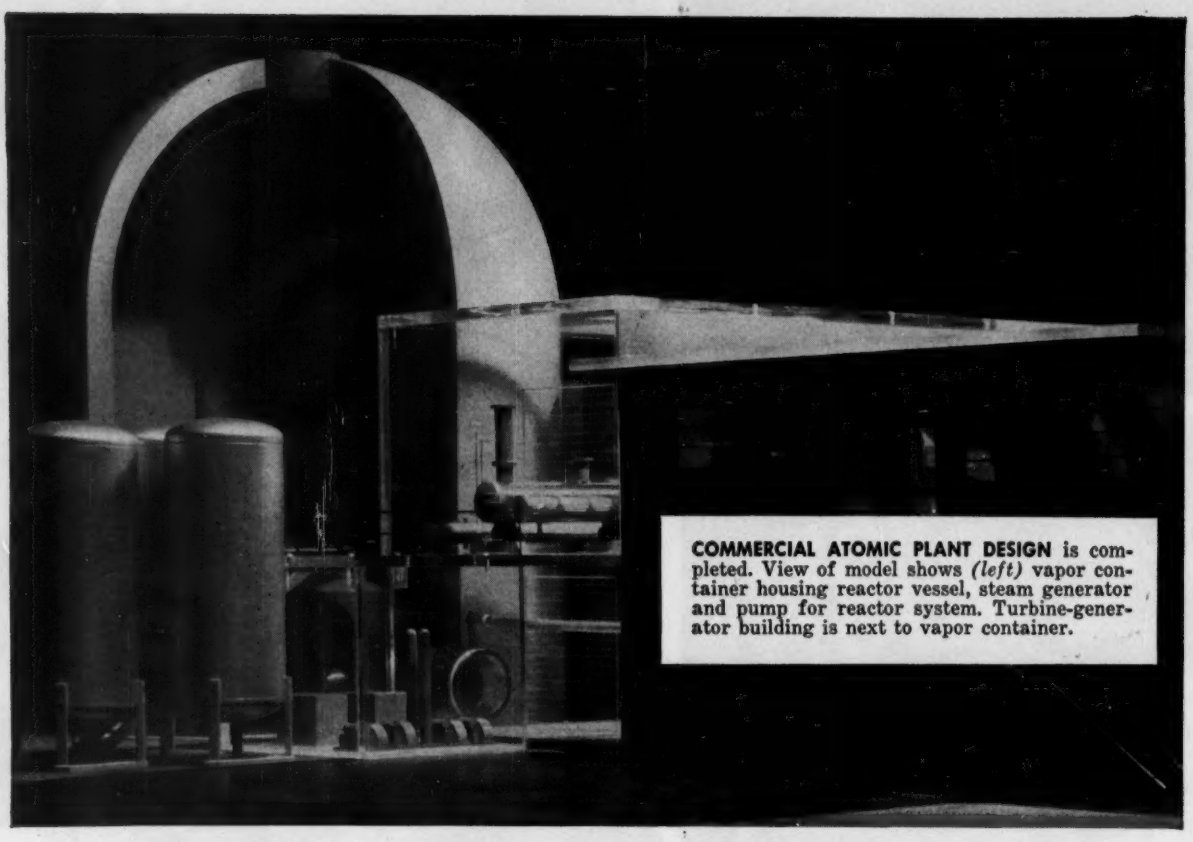
TO HELP GUARD against a long outage, General Electric builds turbine nozzle-diaphragms of tough, sturdy construction. And here's how they help. Should foreign materials enter the steam path, these rugged nozzle-diaphragms "compartmentalize" damage to a small area. This greatly simplifies bucket repairs or replacement.

GENERAL ELECTRIC MANUFACTURES these diaphragms from solid castings or plates carefully machined to shape. Nozzle partitions are machined from solid chrome-iron alloy and welded to, or cast integral with, the webs. These partitions must direct the steam flow at the proper angle and velocity to the adjacent buckets.

In this and many other areas of research G.E. is working with electric utilities and consulting engineering firms to design the power makers for tomorrow's load growth. For more information on General Electric turbines write for GER-905, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, N. Y. 254-40

Progress Is Our Most Important Product

GENERAL ELECTRIC



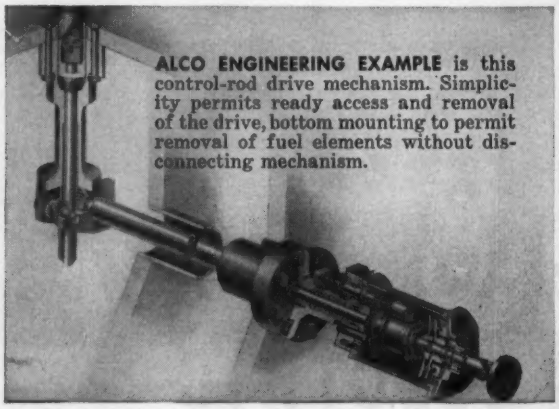
COMMERCIAL ATOMIC PLANT DESIGN is completed. View of model shows *(left)* vapor container housing reactor vessel, steam generator and pump for reactor system. Turbine-generator building is next to vapor container.

ATOMIC POWER IS AVAILABLE NOW

ALCO'S atomic power plants are already designed and engineered; the first is now being built; commercial models can generate stable and economical power

ALCO's atomic power plant is not a dream of the future. It's a reality. The first unit, now being built, will be in operation by early 1957, and similar ALCO atomic plants can be purchased to generate commercial power.

Design and engineering are complete for these pressurized-water atomic plants to about 12,000 kw. This means that their cost is lower than experimental reactors, and delivery time shorter.



ALCO ENGINEERING EXAMPLE is this control-rod drive mechanism. Simplicity permits ready access and removal of the drive, bottom mounting to permit removal of fuel elements without disconnecting mechanism.

An ALCO atomic power plant can be economical in locations where conventional fuel transportation or power transmission is costly. In these high-cost fuel areas, in cases of high transmission costs, or where no source of hydroelectric power is available, the ALCO atomic plant's operating cost may mean a saving. And the ALCO atomic plant is reliable in operation.

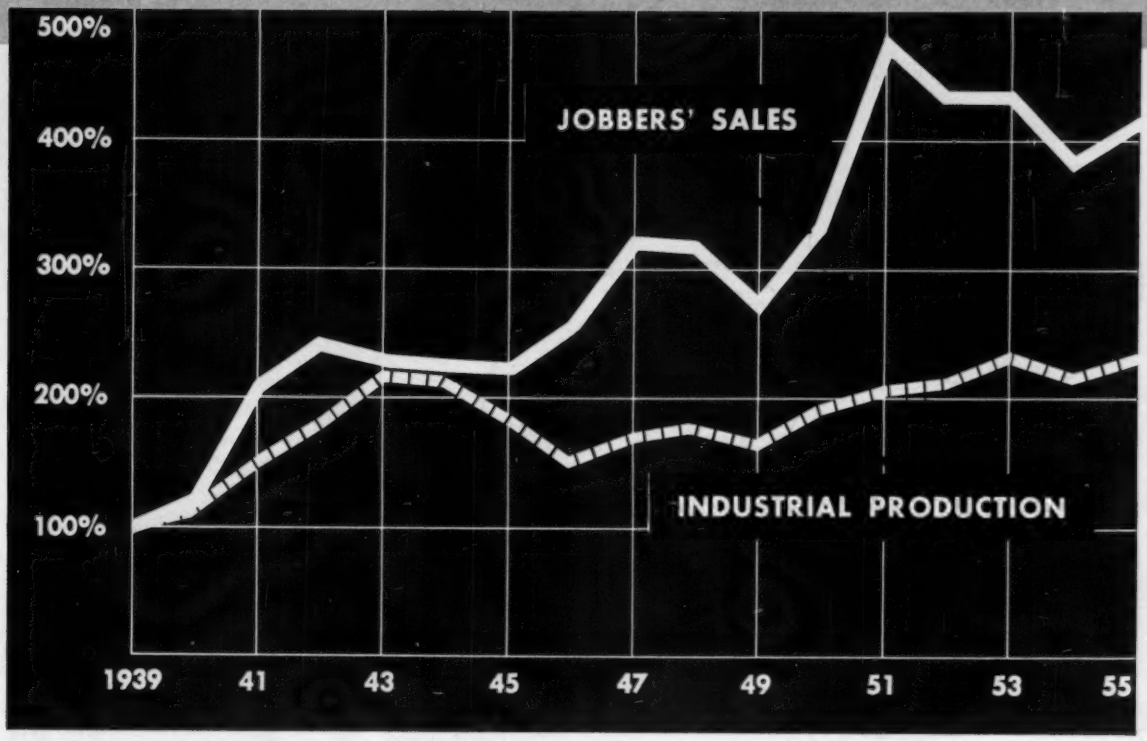
For full information relating to your specific project, contact your nearest ALCO representative or P. O. Box 1065, Schenectady 1, N. Y.

ALCO

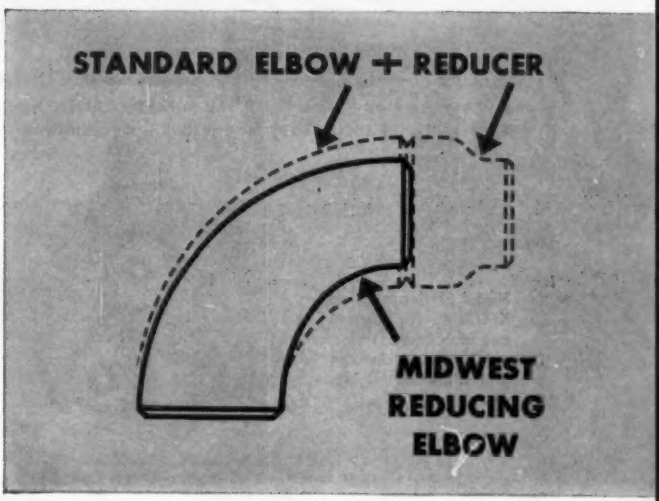
ALCO PRODUCTS, INC.

NEW YORK

JOBBERS Prevent Hardening of the ECONOMIC ARTERIES



The chart above shows that the jobber is now handling a larger share of industrial goods than ever before. Users are finding it to their advantage to look to him for more of their needs. The jobber reduces the user's inventory, assures prompt delivery, provides technical assistance when needed . . . and many other benefits. Are you using him to your own best advantage?



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Jobbers Save You Money, Time and Trouble on Welding Fittings

Midwest Jobbers have the most complete line of welding fittings . . . which often permits them to improve or simplify piping. Only Midwest jobbers offer you a full size range of reducing elbows that take the place of two fittings . . . a straight elbow and a reducer, thus saving space and one weld. There are many other advantages to be gained by using Midwest Welding Fittings . . . see for yourself . . . ask for Catalog 54.

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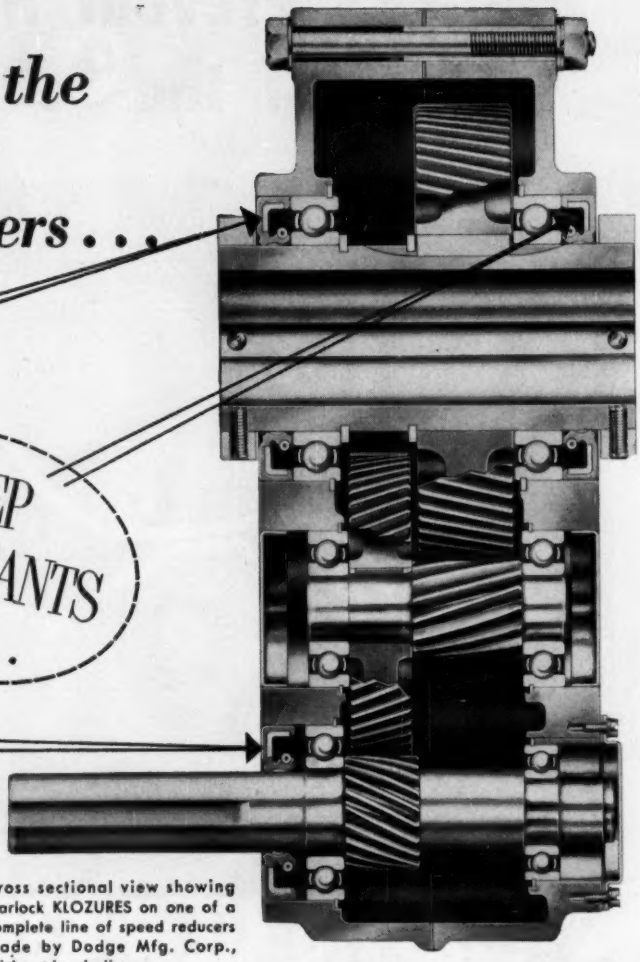


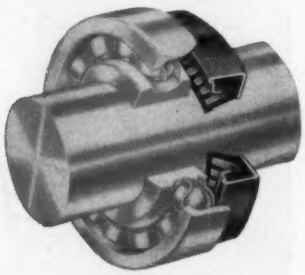
Cross sectional view showing Garlock KLOZURES on one of a complete line of speed reducers made by Dodge Mfg. Corp., Mishawaka, Indiana.

Makers of such fine precision products as The Dodge Torque-Arm Speed Reducer will not compromise when specifying oil seals. They know that the reputation of their entire product may depend on the quality of the oil seals they put in it.

Think about this the next time you have occasion to specify oil seals, and we think you'll choose Garlock KLOZURE Oil Seals—guaranteed to do the job you specify with minimum power loss and heat generation.

KLOZURES are available in a complete range of types and sizes. Therefore, be sure to call in one of Garlock's 125 trained sales engineers right at the start. His experience will save you time and money. Or, write today for Catalog No. 10.

Registered Trademark



Model 53 finger spring KLOZURE for normal and high speed service, applied to a shaft to protect the ball bearing.

THE GARLOCK PACKING COMPANY, Palmyra, New York

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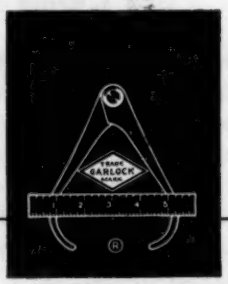

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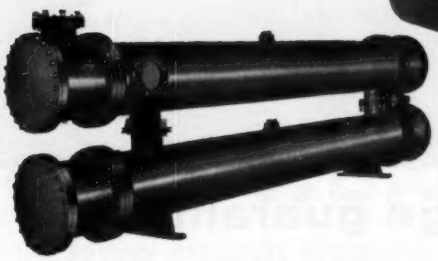
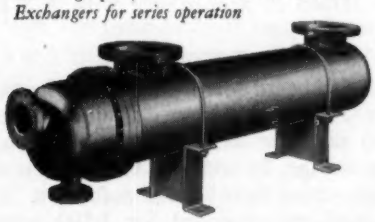
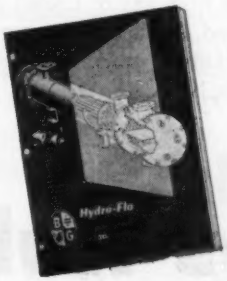


Two single pass, channel head B & G Heat Exchangers for series operation



B & G Heat Exchanger with U-bend tubing



For additional information on B & G Heat Exchangers send for Catalog DM-1150.

B & G shell and tube Heat Exchangers give you *more value per dollar because they are built that way!*

Basically efficient in design, these units are offered with straight and U-bend tubing. Ample material thicknesses in every detail and high tensile strength bolting are assurance of lasting strength and long operating life. Full tube bundles and close tolerances between shell wall and baffles prevent slippage of fluid and assure maximum heat transfer. Units can be furnished with tubing of copper, steel, several of the stainless steels and other non-ferrous alloys.

B & G Heat Exchangers are built to ASME Code U-69 requirements and can be certified by Hartford Steam Boiler and Inspection Service.

Whatever your heat exchange problems may be, remember that the B & G engineering staff is always available for consultation.

BELL & GOSSETT
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Dept. EL-36, Morton Grove, Illinois
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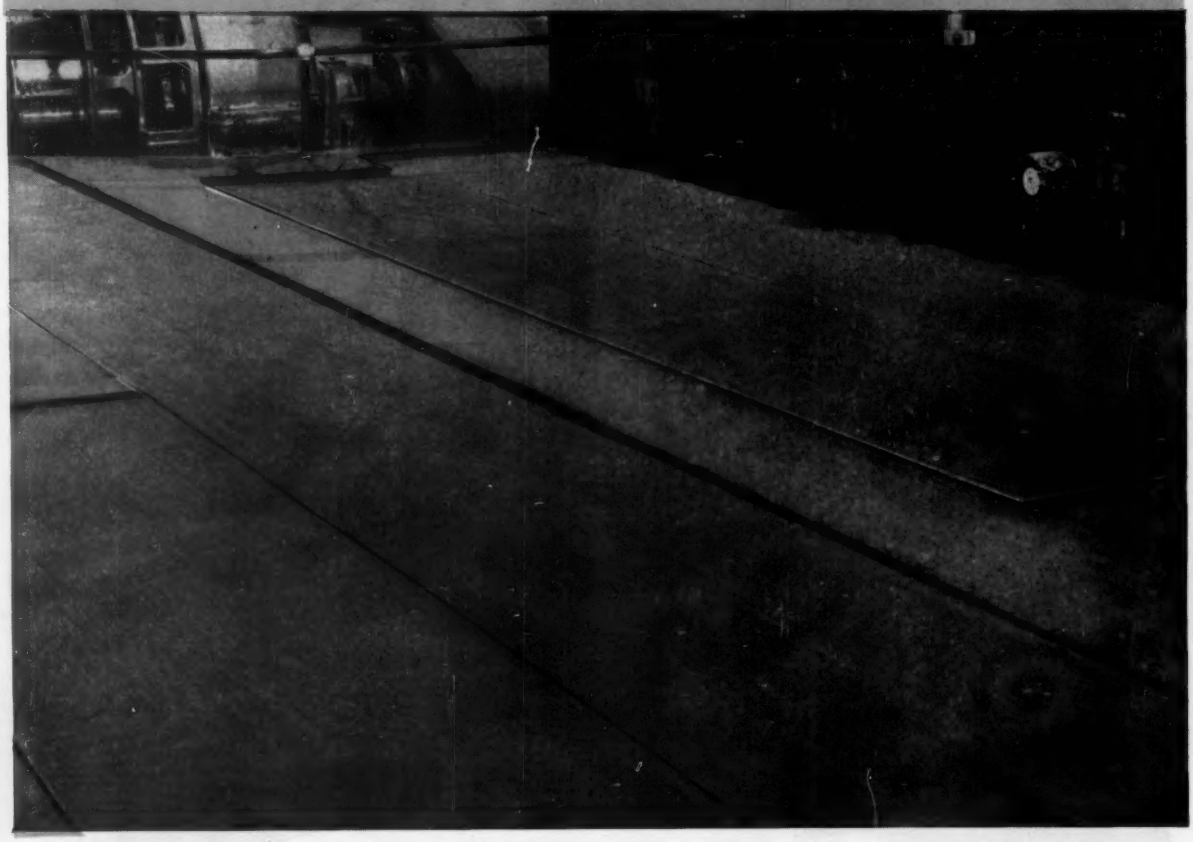
Insulate electrical apparatus with U. S. Switchboard Matting



Service at indicated voltage guaranteed!

Factories, mines, utilities, and railroads who must insulate electrical equipment against dangerous voltages find U. S. Switchboard Matting does a full protective insulation job. It has been tested over ***entire areas*** with stated potential to *guarantee service at indicated voltage*.

Style E-9838

U. S. E-9838 Switchboard Matting has been electrically tested in accordance with A.S.T.M. Spec. (D178-24), spot-tested for 40,000 volts dielectrical strength or better, proof-tested at 15,000 volts over the entire area and recommended for use up to 3,000 working voltage.

In addition, U. S. E-9838 Switchboard Matting is stenciled on the back – every three (3) feet as follows: "Electrically tested in accordance with A.S.T.M. (D178-24)"

Style E-2306

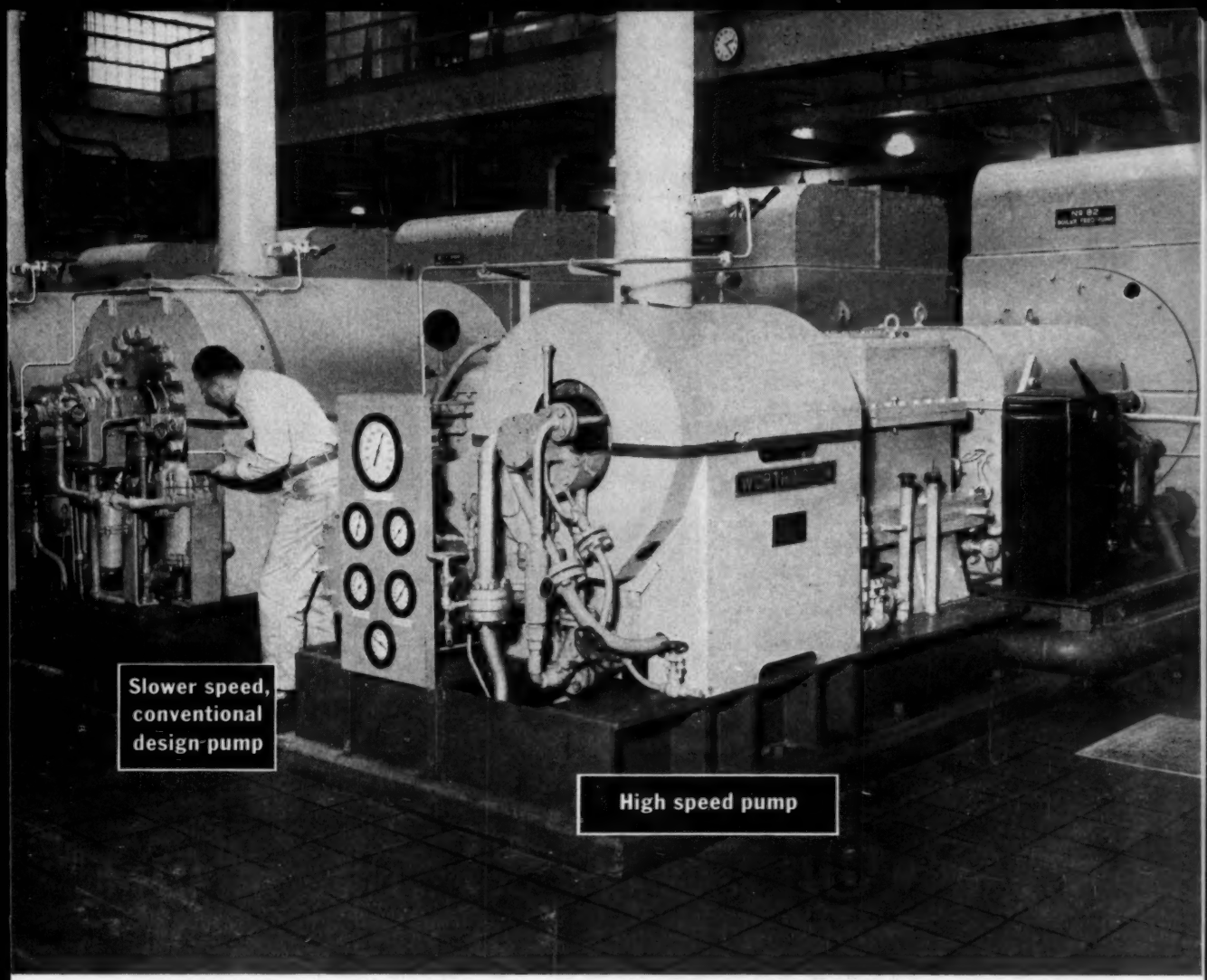
U. S. E-2306 Switchboard Matting has been electrically spot-tested for 20,000 volts and dielectrically proof-tested at 7,500 volts and recommended for use up to 1,500 working voltage. In addition, this grade is stenciled on the back – every three (3) feet as follows: "Electrically tested and recommended for 1,500 working voltage."

Obtainable from any of United States Rubber Company's selected distributors or any of the 27 "U. S." District Sales Offices, or write to us at Rockefeller Center, New York 20, N. Y.

US RUBBER

Mechanical Goods Division

United States Rubber



6,000 . . 8,000 . . 10,000 rpm?

How much speed for modern boiler feed pumps?

With the trend towards superpressure power plants, a new look is being taken at existing boiler feed pump designs.

It's apparent that pressures as high as 5,000 psi cannot be reached economically at conventional speeds of 3,600 rpm without sacrificing reliability.

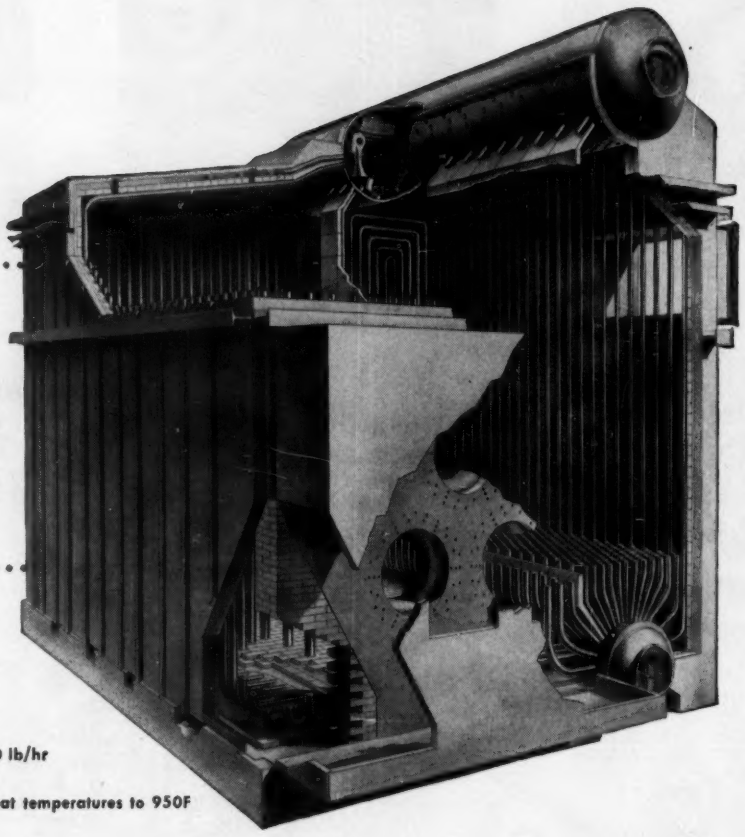
The 9,000 rpm Worthington pump above breaks through the speed barrier. Alongside a conventional unit with duplicate pressure and capacity ratings, its smaller size is dramatically evident. And this means greater reliability, lower costs. In operation since 1954, it has given satisfactory and reliable service in the new Kearny Generating Station of Public Service Electric and Gas Company, Kearny, N. J.

Twenty-two more Worthington high speed pumps on order. Speeds range from 6,500 to 9,000 rpm. If necessary, Worthington sees no reason why operating speeds shouldn't go even higher, without departing from experience-proved construction principles.

For more information, get in touch with your nearest Worthington District Office. If you'd like a copy of Bulletin RP-703, an interesting discussion of "High Speed Feed Pumps For Superpressures," write to Section C65, Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont. C-6-5

WORTHINGTON

Series "SC" STANDARD Steam Generator



FUELS: Oil or Gas
CAPACITIES: 50,000 to 150,000 lb/hr
STEAM PRESSURES: to 1500 psi
STEAM TEMPERATURES: Superheat temperatures to 950F

PRE-ENGINEERED FOR SAVINGS

in first cost, installation, operation, maintenance

Series "SC" Steam Generator is of the pre-engineered, standardized design, with all exterior and structural details fixed. Available in nine sizes, with capacities of 50,000 to 150,000 lbs steam per hr, it incorporates many advanced design features — as noted in the accompanying list — that make possible important savings in industrial steam costs.

Burners, controls, upper drum mountings and other equipment requiring attention are located at the front of the unit. Heat recovery equipment and fans can be placed near the operating aisle for either single or multi-unit installations, providing unusual accessibility and ease of operation.

Write us today for further information on how the Series "SC" Standard Steam Generator can meet your individual plant needs for power or process work. *Foster Wheeler Corporation, 165 Broadway, New York 6, New York.*

FEATURES AT A GLANCE

- Completely water-cooled furnace
- Over 19-foot firing depth
- Unrestricted circulation
- All-welded casing
- Fully drainable superheater
- Efficient convection surface
- Bottom supported unit
- Steam purifying system
- Full insulation

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

The fight for boiler safety

LAST WEEK, at Quebec's Seigniory Club, I heard Bill Ferguson make his farewell report as chairman of the Uniform Boiler and Pressure Vessel Laws Society. And I couldn't help thinking what this quiet man and the organization he headed have done for power-service men everywhere.

Most of us are aware of the benefits that flow from general adoption of the ASME Code for boilers and pressure vessels. When you buy a "Code" boiler, you know:

1. It's designed to safety standards.
2. Qualified inspectors have tested it to insure construction to meet these standards.
3. It will satisfy virtually any local, national or even international requirement.

And because working to a uniform code permits manufacturing standardization, you know your Code boiler is economical.

Today, 35 states and all U.S. territories have boiler laws based in whole or in part on the ASME Code. And a Code boiler is acceptable anywhere in the U.S.A., the territories and Canada. This fortunate state of affairs didn't just come about by itself. Nor does it maintain itself.

To the twin jobs of helping put good boiler laws on the books, and keeping them there unadulterated, the Uniform Boiler and Pressure Vessel Laws Society has been dedicated since 1915. It is supported by the voluntary contributions of all who are interested in boiler safety—manufacturers, insurance companies and public utilities, for example.

The Society provides information for local groups interested in sponsoring boiler laws. Its representatives confer with public officials and legislators, and co-operate with those who enforce boiler and pressure-vessel laws and regulations.

All this sounds sedentary, but Bill Ferguson can tell you that's strictly an illusion. In his ten years as full-time chairman, Bill's travel agent has logged him for over a million miles.

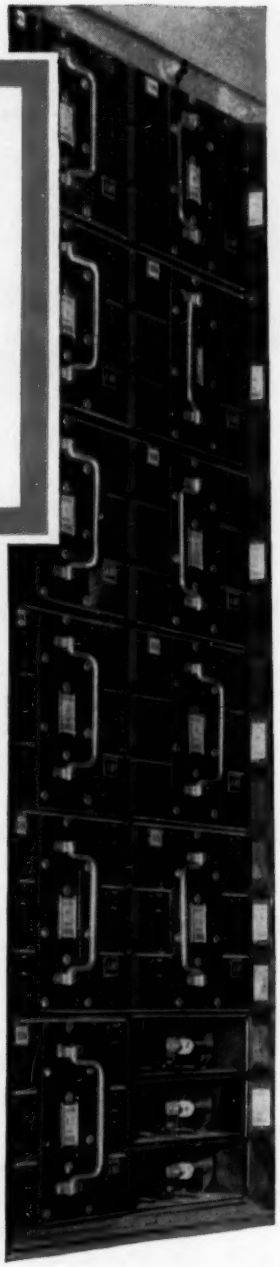
Bill is apt to be less statistical about it—just says he travels continuously in the U.S. and Canada. Certain it is that when a law is to be sponsored in a state without one, Bill Ferguson has been there with copies of the Society's model law and, more important, with his own wise counsel. And where legislative action has threatened the integrity of an existing law, Bill has been on hand to help defend the Code-based statute.

Now retired, Bill expects to begin traveling for his own pleasure. And he'll be able to do so without worry over the affairs of the Society that has been so much a part of his life during the past 40 years. His successor as chairman is another "Bill"—William Heinrich, internationally known safety engineer.

I'm sure POWER readers join me in wishing Bill Ferguson many thousand miles of "travel for fun." To Bill Heinrich should go not just good wishes but a pledge of support. As individuals, and as members of engineering groups, every power-service man should realize that the fight for nationwide boiler safety is never won. We should be doing our best to get laws where there are now none. And we should be vigilant in defending existing Code-based boiler and pressure-vessel laws against the erosive action of self-seeking groups with special interests.

. . . "After these two experiences with FUSETRON dual-element Fuses, we use them throughout our Entire Plant."

J. W. Sanders, CHIEF ELECTRICIAN
(Division of Simmons Co.) ROSEMARY MFG. CO.
ROANOKE RAPIDS, N. C.



"SOLENOIDS WERE BURNING UP AND STARTING *FIRES* — *Until we changed to FUSETRON FUSES.*"

"A fire in our weaving room is just about the gravest danger we can face. If the fire isn't checked immediately, it can quickly spread throughout the room.

"You can imagine then how concerned we were with fires started by solenoids burning up in heavy lint locations. With 500 looms in use in 3 weaving rooms, we didn't know where to expect the next fire.

1

"We definitely had to find safer solenoid protection than we were getting from one-time ordinary fuses in use. We decided to try Fusetron dual-element fuses and installed them in the summer of 1954.

"It was a big relief when Fusetron fuses turned out to be the answer. I'll knock on wood, but we haven't had a fire since we installed them.

"In addition, this move to Fusetron fuses also cut production costs. We eliminated needless down-periods and we no longer have to repair or replace burned-out solenoids."

"WE CUT UNNECESSARY DOWN-TIME AND MAINTENANCE *COSTS By installing FUSETRON FUSES.*"

"Several years ago we had a heating problem in our main panels that was causing ordinary renewable fuses to blow.

"These outages occurred several times weekly in each panel, so down-time costs were really adding up and costing our company money.

"Also, after each blow our maintenance men would spend time checking the circuit for trouble, only to find the outage was caused by excessive heating in the panel.

2

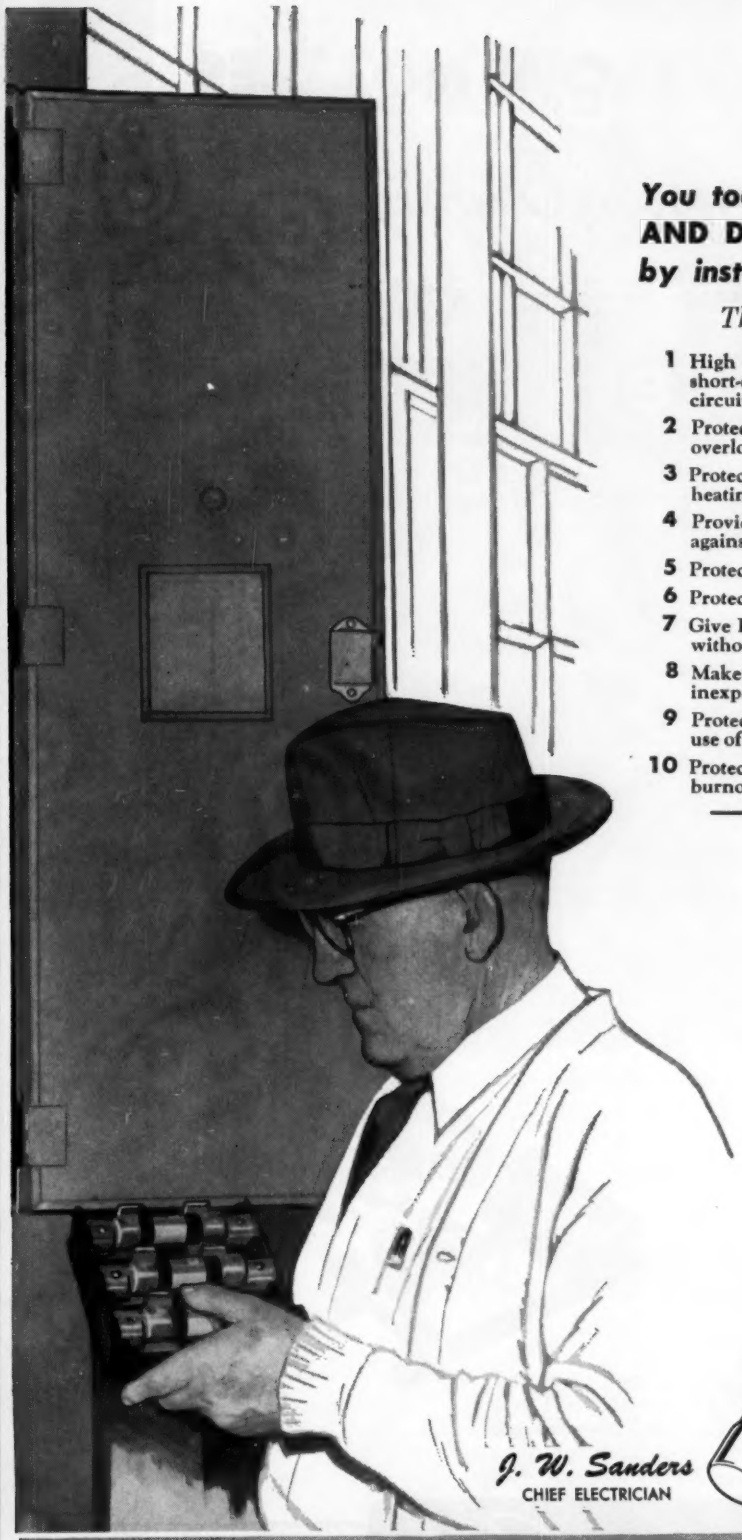
"We discussed the situation with a salesman and he showed us that Fusetron dual-element fuses were cooler operating and would eliminate our trouble.

"They sure did! The change to Fusetron fuses of proper size for safe protection was completed in 1953. We haven't had any unnecessary shut-downs since then.

"Our maintenance men sure like the change. Any outage today indicates trouble, and the men know they are not wasting time when they check the circuit.

"Because of this and other satisfactory experiences with Fusetron fuses, we individually protect all our motors with them as well as using them throughout the rest of the electrical system.

"I wish we had kept a record to show how much money we saved by equipping each motor with Fusetron fuses. I am reasonably certain that the difference in motor burnouts alone would represent considerable money."



You too, CAN REDUCE FIRE HAZARDS AND DOWN-PERIODS by installing FUSETRON FUSES!

They provide 10 Point Protection

1. High interrupting capacity—protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2. Protect against needless blows caused by harmless overloads.
3. Protect against needless blows caused by excessive heating—lesser resistance results in cooler operation.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect motors against burnout from overloads.
6. Protect motors against burnout due to single phasing.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Make protection of small motors simple and inexpensive.
9. Protect against waste of space and money — permit use of proper size switches and panels.
10. Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS., Use BUSS Hi-Cap Fuses . . .

They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

J. W. Sanders
CHIEF ELECTRICIAN

Play Safe! Install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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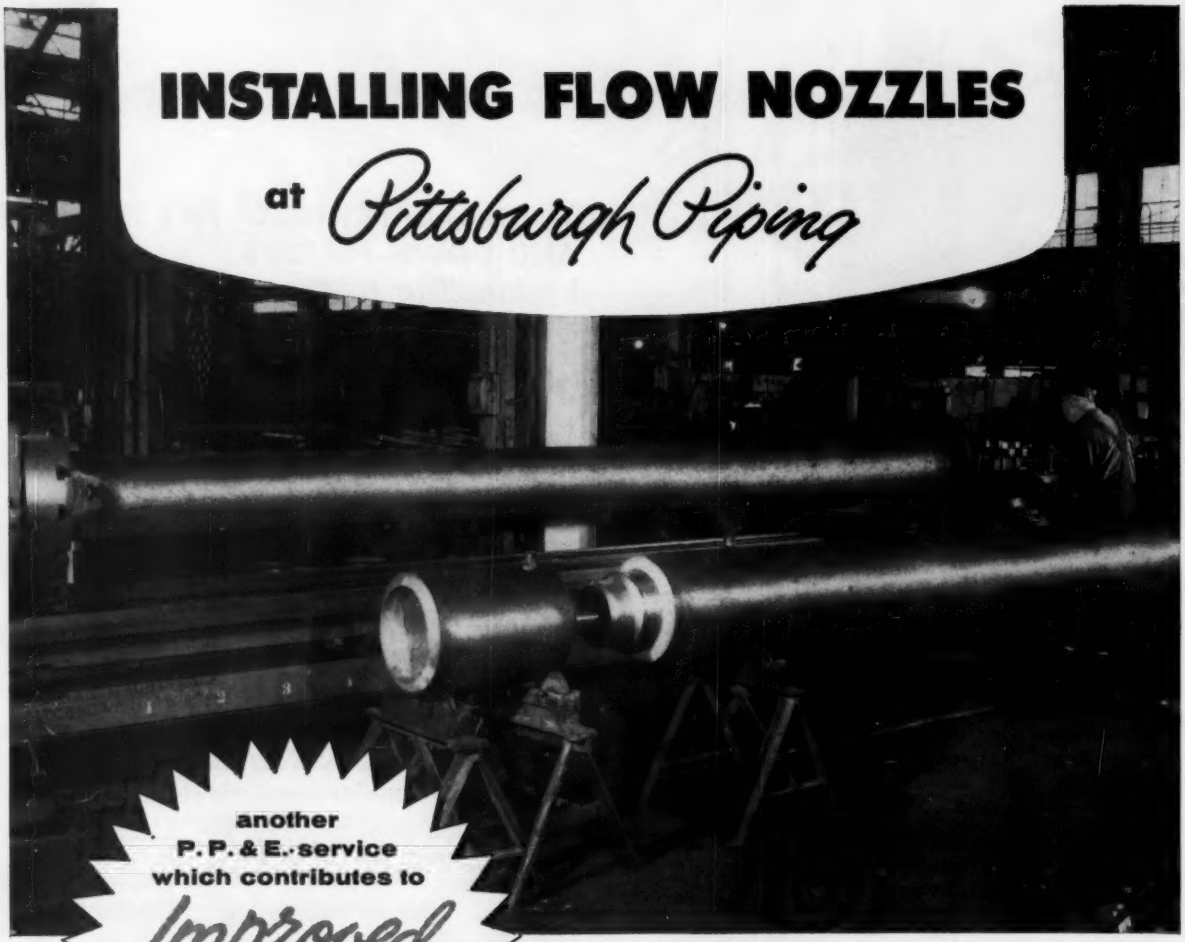
758

INSTALLING FLOW NOZZLES

at *Pittsburgh Piping*



another
P. P. & E. service
which contributes to

Improved

HIGH-TEMPERATURE
HIGH-PRESSURE
PIPING

Pittsburgh Piping's precision installation of flow nozzles in high-pressure piping is the result of extremely skillful machining, fitting, and welding by experienced craftsmen. This is another example of advanced techniques — available at Pittsburgh Piping — which provide greater safety, higher efficiency and longer life from high-pressure, high-temperature piping.

Precision fitted flow nozzles; largest shown is for 16" main steam line, 4" and 6" sizes in foreground are for boiler feed lines.

PRODUCTS AND SERVICES

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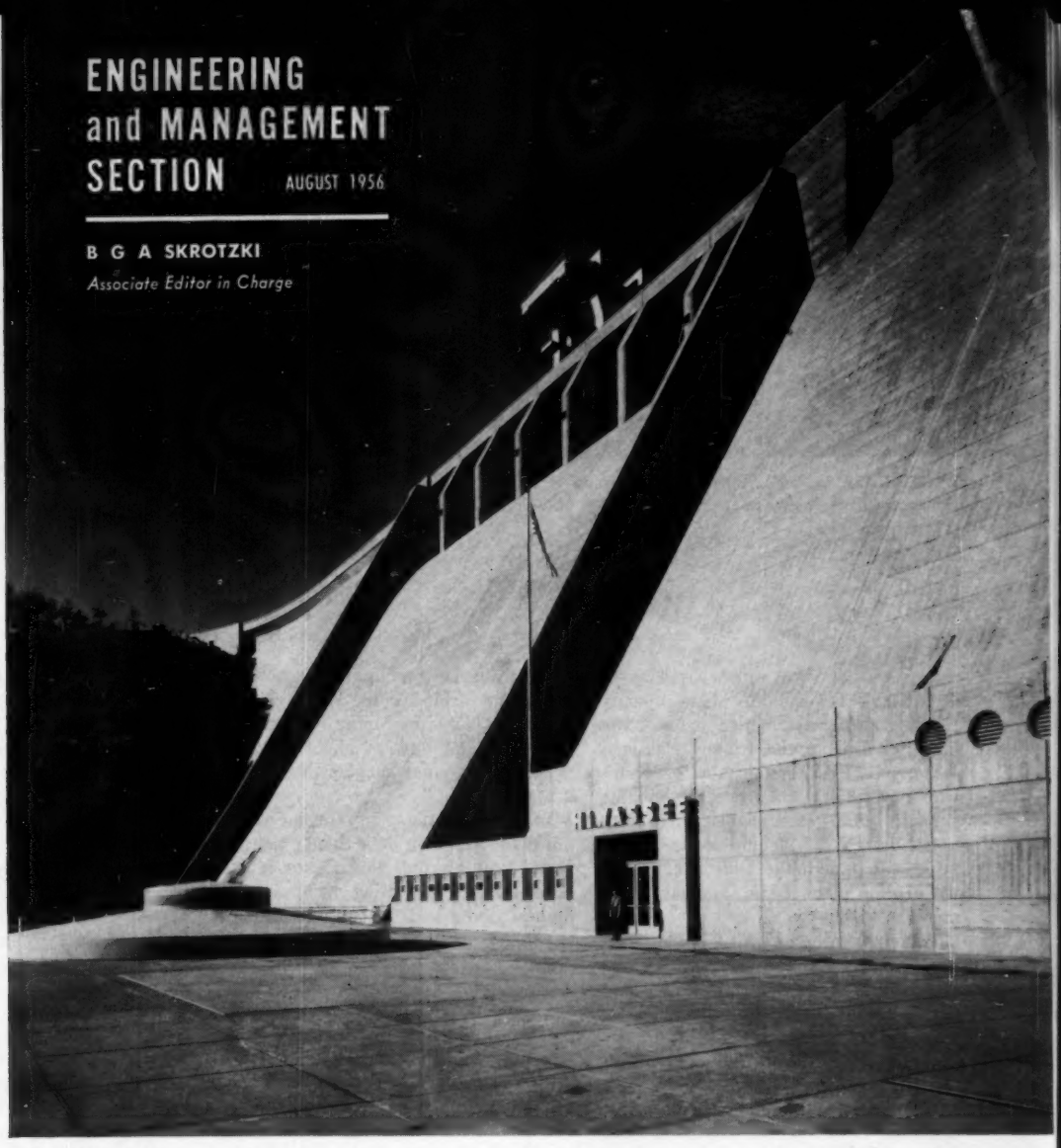
Associate Editor in Charge



HIWASSEE DAM on Hiwassee River in southwest corner of North Carolina develops 190-ft total head

World's largest pump-turbine...at work

By C W BELL Jr
Civil Engineer
Office of the Chief Engineer
Tennessee Valley Authority

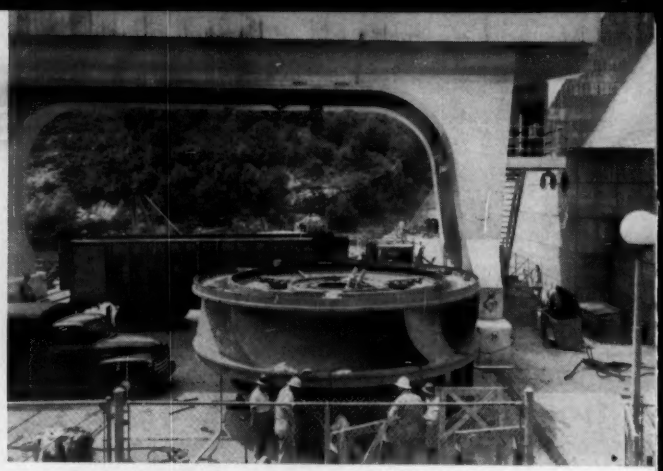
► THE WORLD'S LARGEST PUMP-TURBINE began full operation on May 24, 1956 at TVA's Hiwassee Dam, as Unit 2. For pumping operation, the unit is rated as a 102,000-hp motor driving a centrifugal pump; for generation, it is rated as an 80,000-hp turbine driving a 59,500-kw generator.

As a turbine, the unit draws 4250 cfs water at 190-ft head. As a pump, the unit delivers 3900 cfs water against a 205-ft head. Ratings are: (1) as a motor 102,000 hp, 80-C rise, 0.95-pf leading, 13.5 kv (2) as a generator, 70,000 kva, 60-C rise, 0.85-pf lagging, 13.8 kv. Unit normally turns at 105.9 rpm. Turbine diameter at center line of the distributor measures 266 in. The francis-type runner is larger in diameter than any other.

Allis-Chalmers Manufacturing Company built the unit under contract at a price of $1,377,746 for the pump-turbine and $1,420,174 for the motor-generator. Total cost of Unit 2 including switchyard and powerhouse extension will be about $6,526,000.

Benefits. New unit raises the plant

SCROLL CASE for 102,000-hp pump-turbine is set 6 ft lower than conventional turbine to meet needs of pumping operation



PUMP-TURBINE RUNNER is the world's largest francis runner. Shipped in three pieces, it was bolted together at the site

rating by its own rated capacity of 59,500 kw. Dependable plant capacity rises by a slightly smaller amount, 55,500 kw. During the winter peak-load season on TVA system the new unit will have 8500 kw more dependable capacity than an equal-sized conventional unit. Near the end of the critical peak-load period, the additional capacity of the plant could amount to as much as 44,000 kw.

Principal value of Unit 2 is the peaking capacity it can add to system capability during the critical load period. In addition, during a dry year the plant capability rises substantially while a conventional unit would add very little.

We estimate the pump-turbine unit will raise the combined average annual energy of the next downstream plant, Apalachia, and Hiwassee from 732,000 mwhr to 761,000 mwhr, a rise of 29,000 mwhr. This includes generation by Unit 1 at Hiwassee, a 57,600-kw conventional turbine. Tailwater of Hiwassee is head of the reservoir for Apalachia. The generations are obtained as follows:

	Millions of kwhr		
Period	*Unit 1*	*Units 1 & 2*	*Increase*
Nov-April			
On peak	135	184	49
Off peak	146	125	–21
Subtotal	281	309	28
April-Nov			
Unclassified	451	452	1
Total	732	761	29

During an average year the benefits are estimated at $411,000 and $565,000 for the conventional and pump-turbine, respectively, less annual costs. While the pump-turbine costs are higher, it develops 8500 kw more dependable capacity and gives about $39,000 greater net annual benefits than a conventional unit.

In addition, the pump-turbine draws down the reservoir less than a conventional unit would. This makes it possible to hold operating headwater at highest level and maintain maximum capability of the 2-unit plant during system peak-load seasons.

The Apalachia project downstream can regulate the peak discharges of the pump-turbine and Unit 1 with a reasonable amount of reservoir fluctuation. With two conventional units at Hiwassee, the Apalachia reservoir would vary in level to a greater extent. This would waste water through Apalachia's spillway gates and lower the average operating head on the plant. In this way the pump-turbine increases the generating efficiency at Apalachia too.

Another feature of the pump-turbine unit is its lower runaway speed. Unit 2 will rise to about 161 rpm compared with 235 rpm for a conventional unit. This lower speed favorably affects the design of the motor-generator.

Operation. As a turbine-generator, Unit 2 will be started in the same manner as its companion, Unit 1. As a pump-motor the starting sequence differs in several respects: After closing the wicket gates, compressed air forces the tailwater level below the pump-turbine runner. The motor-generator then starts electrically powered and accelerates to normal speed with the runner turning in air. Reducing the air pressure allows the tailwater to rise and refill the draft tube. Opening the wicket gates puts the pump into full operation, discharging water up the penstock into the reservoir.

Normally, Units 1 and 2 will run at maximum capability for 50 to 60 hr per week to carry system peak and off-peak load between November and April. During the remainder of the year the units will run as near their best efficiency as stream flow and system load will allow. Unit 1 will be idle when Unit 2 performs its off-peak pumping operations.

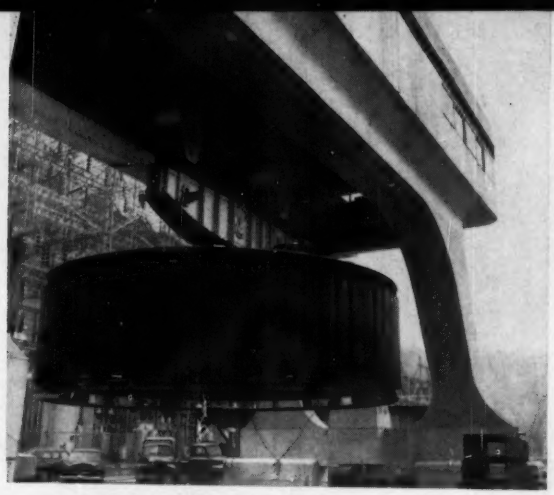
Unit 2 turns clockwise when generating and counterclockwise when pumping. About three kw can be generated by the unit for every four kw used in pumping.

The pump-turbine will have no adverse effect on fish life. The same number of fish will survive a trip through a pump-turbine as through a conventional turbine runner. In fact, fish do not tend to travel into the pump intake during pumping operation as they do into a turbine inlet during generating operation.

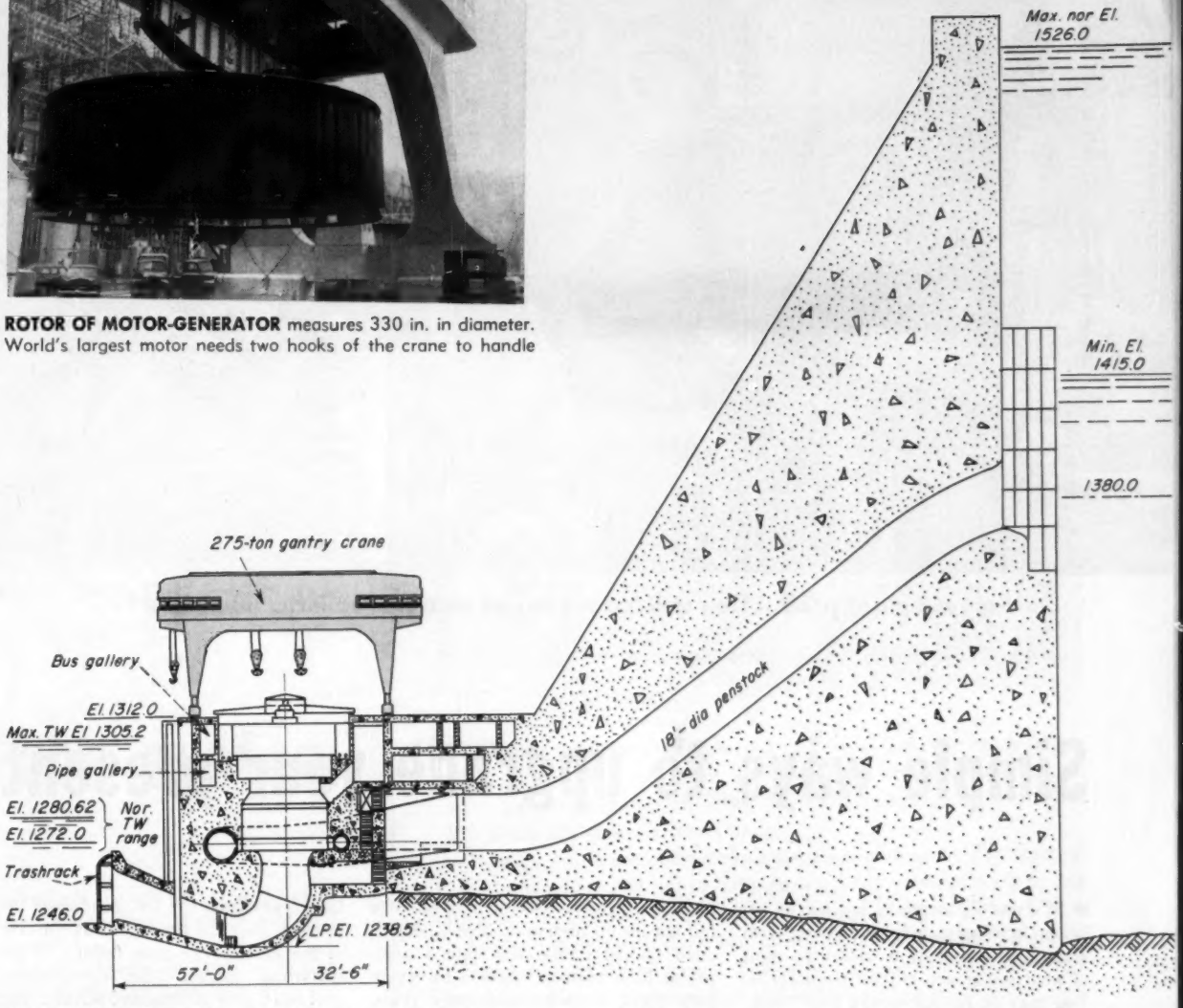
History. Pumped storage was first used in Germany and Switzerland over 50 years ago. Most of these projects used dual units with separate pumps and turbines on a common shaft. Several reversible units have been installed in recent years.

Two 8100-hp pumps and separate 24-mw turbine-generators were installed in the first large American plant, completed in 1928, the Rocky River Plant on the Housatonic River owned by the Connecticut Light & Power Company. These pumps were converted to reversible pump-turbines in 1952 by an electrical reconnection of the pump motors. This increased station capacity by about 7 mw.

Recent units. Buchanan Power Plant in Texas of the Lower Colorado River Authority is the second large pumped storage installation in America. Using off-peak steam power, a 13,450-hp sep-



ROTOR OF MOTOR-GENERATOR measures 330 in. in diameter. World's largest motor needs two hooks of the crane to handle



PUMP-TURBINE SETTING uses trash racks on draft tube outlet to prevent trash entering during pumping operations. Tailwater blowdown used on conventional units during synchronous condenser operation, helps reduce the motor starting torque

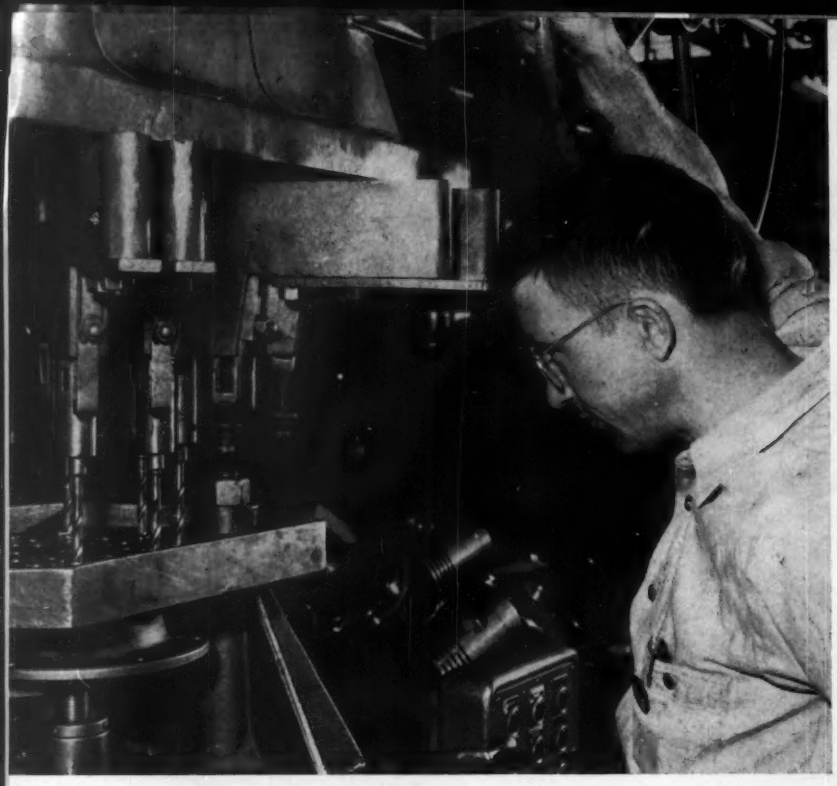
arate pump delivers 800 cfs in the reservoir through the same penstock that supplies a new 12,500-kw turbine-generator unit. Without the pump, a new generator would not have been feasible at the plant.

The 362,000-gpm pump and turbine-generator began operating in Sept 1950. Need for unusually high efficiency and for using the pump motor as a synchronous condenser during generation led to selecting separate pump and generator. About 30 hr of pumping yields 20 hr of generation at Buchanan.

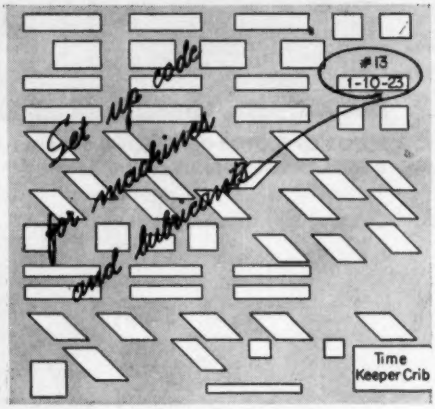
The Colorado-Big Thompson Project of the Bureau of Reclamation uses pumped storage features. A pumping station at Granby Lake on the west side of the Continental Divide boosts upper Colorado River water to the higher level Grand Lake. From here the water flows by gravity through a 13-mile tunnel under the Divide and down the eastern slope of the Rocky Mountains. The water generates power at four plants, the last being the Flat Iron Plant. Flat Iron houses two conventional units and one pump-turbine unit. The 13,000-hp pump uses low-cost off-peak power to supply 370 cfs water to the higher-level Carter Lake irrigation system. While the pump primarily supplies irrigation water the unit also develops 8500 kw of power during system peak-demand periods. The Flat Iron pump turbine started in 1953.

New units. Pump turbines are now building for two San Paulo Light & Power Company plants in Brazil. The Pedreira Pumping Plant will have an 1800-cfs pump rated at 19,000 hp as a turbine; the Edgar de Souza Plant will have a similar unit rated at 15,900 hp.

The Hydroelectric Commission of Ontario plans to install pump turbines totaling 236,000 hp in its Sir Adam Beck Generating Station No. 2 at Niagara Falls. These units will develop 170,000 kw of system peak power.



By JAMES E FARRY,
Alemite Company, Buffalo, N.Y.



Smooth plant production still leans heavily on a . . . realistic lube chart . . .

Simple ways to upgrade your present

► IT'S ONE PROBLEM to lay out an efficient lubrication scheme starting from scratch. It's another to make the most of what you've got, at least temporarily. You may be in this second boat, working along with too few men whose background in industrial lubrication is scanty. So you search out advice from various sources and find the answers often contradictory. What to do? Well, the advice outlined on these four pages has been field-proven with time. Some of it may well fit your needs. Starting at the beginning:

First step in any lube-improvement plan is to lay out each department on charts, identifying machines by symbols (sample above). A half-dozen rubber symbol-stamps that snap over pencil ends do the trick. On the machine chart, list all machines by name, model, number. Then frame each area using numbered columns, aisles, as bench marks. You then have a floor plan with each machine numbered. At this point introduce the clock and calendar into your plans.

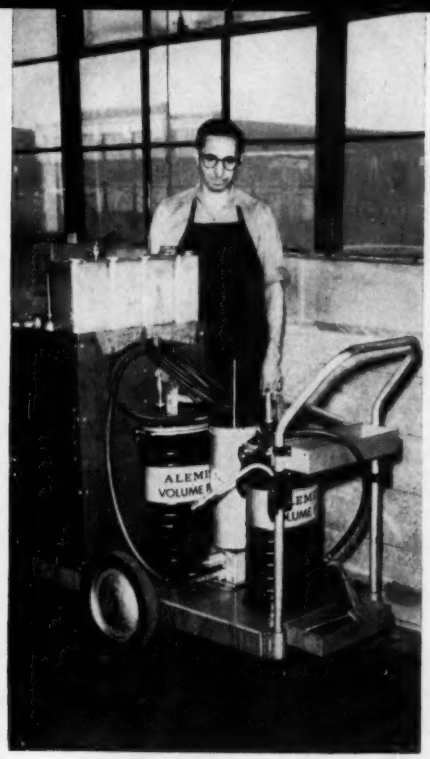
Using machine instruction manuals or advice of your oil supplier, mark in each machine-block a code number indicating recommended lubricant. Use red ink for oil reservoirs, blue for hand-oiled points. Check last date a competent lube engineer made a survey in your plant. If more than three years, chances are the number of lube products can be reduced. And if you are trying to follow all the various machine makers' recommendations, give some thought to the following fact: Most makers still offer lubrication instructions predicated on the supposition that their machine is to have a custodian who has the interest, time, intelligence and responsibility to tend that one machine properly. I have yet to read a lubrication instruction manual, out of thousands scrutinized over many years, that made any reference to other machines in the family their machine is to be a part of. You are the first to see a new machine in relationship to other plant machines and must appraise them as a whole. So have your oil supplier send an experienced lubrication engineer to survey with you, not for you, the actual lube needs of your plant with an eye toward reducing the number of products used.

If you succeed in chopping a few lube types from the list, conditions improve at once, all the way from the task of the lube service man (oiler), to the stockroom storing lube, sub-handling problems, plus streamlined buying. You also reduce the possibility of misapplication.

Once you're squared away on type and number of lubricants, take another copy of the machine chart and actually count points requiring lubrication. Indicate on chart, across each machine block, number of points needing attention each shift, daily, weekly, monthly, etc. The total will surprise you.

Counting lube points should lead you to a promising channel for improvement. Often the points needing constant attention are using oil that must be replenished frequently because it fails to "hang on," or simply doesn't have an adequate reservoir.

Now take a look at the chart and, starting with the first machine, figure out how much of the lube-service man's time each machine takes. To begin, consider the daily routine. Here again you will be surprised at inconsistencies in lube demands of various machines—alike in function but from different



sound gear, plus spotting . . .

lube system

makers. It points up an area where much improvement in plant economics is possible.

Simple changes in lube application methods are your next stop. You may find the service man running a stiff obstacle course daily since many check points are not visible or are hard to get at. Machine designers too often place a weekly check point in a spot where it has to be known and looked for. That kind of reasoning would be fine if that machine were the only one in the plant. But with a host of different machines to service, the time lost in checking the out-of-the-way lube points mounts quickly.

One answer to out-of-the-way lube points is that used by Rochester Products on forming mill stands (sketch, top right). Here all points were connected to a common reservoir with sight-indication for all. Now the service man simply takes a fast walk down the aisle with his eyes open instead of an all-day siege of unscrewing, testing, pouring small amounts of oil in a hundred or more spots.

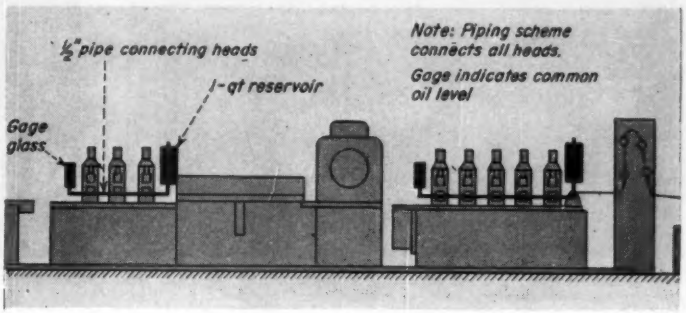
Where a central reservoir is impractical for some hard-to-reach fittings,

These practical design changes prove real timesavers at Rochester Products

Central lubrication systems show many advantages. Most obvious is simply better lubrication—proper quantity delivered at the proper time. And then there's the safety angle.

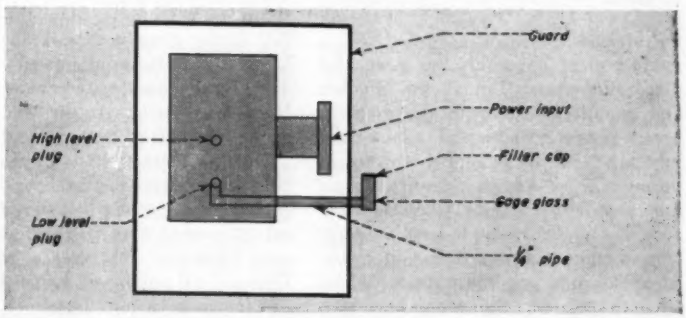
Safety engineers spot the lowly oiler as having one of the plant's most hazardous jobs. Many bearings require personal attention at least once every shift.

But in many plant areas a simple change in present practice shows immediate results without going all out for a central scheme. Following are two cases from the operating records of Rochester Products, Division of General Motors.



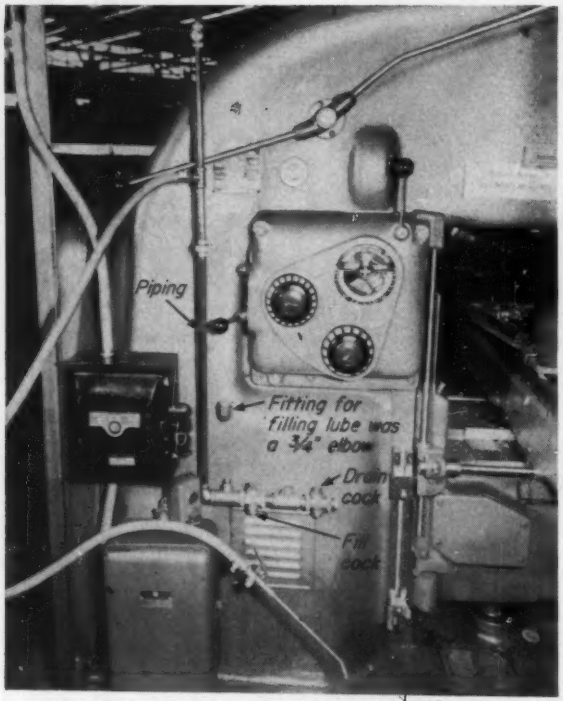
Mill heads for some time presented a lube problem. The heads leaked and checking oil level meant squeezing back of each machine, unscrewing a high-level plug, filling the head, replacing the plug. With 175 heads this took six hours daily.

Now all heads are connected in batteries of four or five through ½-in. piping. On one end of the pipe is a 1-qt container made in our tin shop. A glass gage on other end of the piping shows oil level. Now a lubrication service man walks down the aisle checking oil levels, filling reservoirs where needed. This simple change trimmed five hours off the six formerly needed just to handle mill heads.

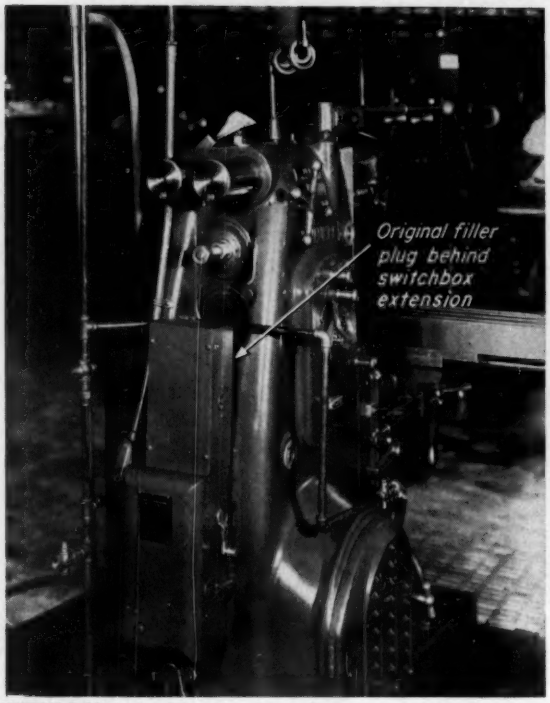


Gear boxes at Rochester Products are always guard-enclosed. So to check oil level, the service man must remove guards, unscrew the high-level plug, add oil, replace plug.

But by running a ¼-in. pipe from the drain plug on each gear set to a gage glass outside the guard, every unit can be serviced without removing the enclosure. If oil is needed add it through filler cap on gage. Saving: 150 man-hours weekly on gear boxes alone.



FILL FITTING for this machine was a ¾-in. close elbow. Pipe change permits draining, filling from same tap through cocks



SWITCH BOX hides filler plug here. Once again, a simple piping change simplified both the oil draining and filling operation

Even the simplest mechanized scheme for lube handling pays dividends

use piping to make the lube application point more accessible.

Take another look at your chart to uncover a better way to carry lubricants through the department. Any conveyance must be big enough to carry all the varied lubricants needed in a specific plant area plus the means for dispensing them. But if the number and quantity of lubricants is so great a man cannot push or pull them, or the lube rig is so big it simply won't pass through aisles or passageways, locate lube supplies in strategic points in the area. It's mighty costly to have the serviceman make trips to a remote oil room. Also, look into possible ways to reduce oil leakage (namely, repair machine seals) as a means of chopping lube consumption and possibly size of lube rig.

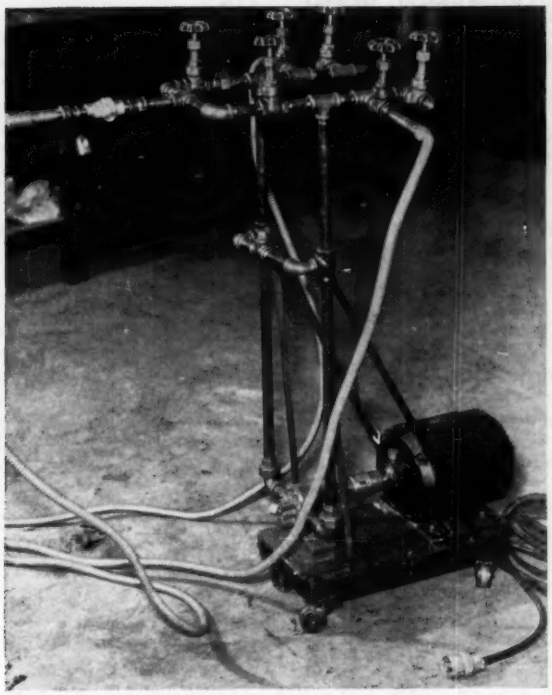
In larger plants don't overlook the machines far from the regular production equipment. Consider lube needs on roofs, in basements, subbasements, and in remote buildings. These points are like scattered islands in an ocean of plant, yet they may be overlooked. Typical: ventilating fans, refrigeration equipment, m-g sets. Often failure of any equipment in this class means a sizeable shutdown, timewise. To care for this equipment properly, you must know what it is, where it is, and how much of it there is. Many plants try, with little success, to mix the job of lubricating remote equipment with the daily production maintenance chores. Here's one way to take this problem out of the hands of chance.

Number these stations as you do machines on the production floor. Analyze each one by spotting location, means of entry, number and type of equipment and lubricants for proper servicing. Take a 5-gal paint pail, hinge the cover and install a hasp and padlock. Put in a reasonable quantity of the type lubricants used in the station. Include a grease gun, oil can, supply of wiping rags and complete instructions for every task at this point. If a ladder is needed, chain one close to the lube pail. Now the service man can go empty handed through the plant, up and down ladders, over catwalks, without carrying anything or having supplies hand-lined to him. Often this simple provision means one rather than two men for the job. When the service man finds his pail supplies running low, he should take note and get replacements before the next service date.

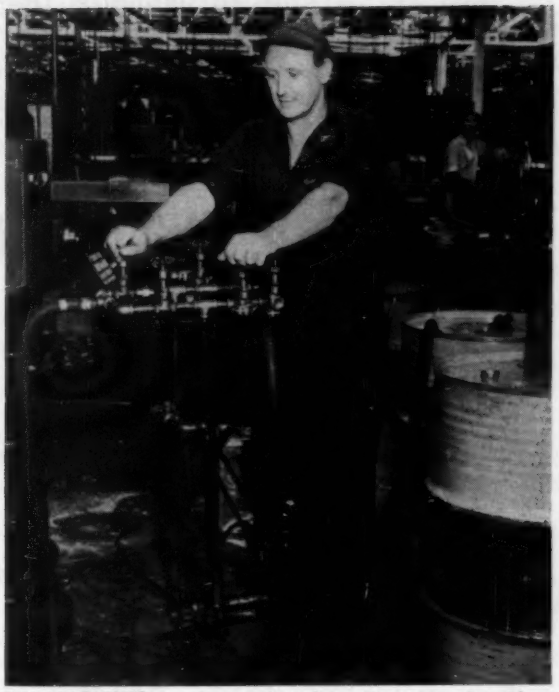
Drain time is important in any planned lube cycle. All reservoirs need draining, flushing, refilling at set intervals—anywhere from a month to a year. Machine makers and oil suppliers alike continually emphasize this step's importance. You'll pay the price in machine damage and lost production if this schedule is not followed religiously. Here's a practical way to handle drain scheduling.

Put a calendar of 365 blank sheets on a spindle board. Date each sheet successively from Jan 1. Starting with machine No. 1 discard such indefinite words as monthly, twice a year, every 3 months, etc. Nail down a specific date. If today is Aug 6 and your men have just drained oil in No. 1, put a note on the Nov 6 page in your lube calendar if that machine should be drained every 3 months. Do this for each machine and you will find about how much manpower and materials you need for proper draining.

Drain plugs mark an area where much time can be saved—and lost. Nowhere is the lack of co-ordination be-



PORTABLE OIL PUMP with double valving arrangement speeds drain and fill time: A single hose connects the pump to machine



TEN MACHINES can be reached from the pump rig without changing position. Here, too, piping connects to hidden drain plug

tween different manufacturers more pronounced than in the type and location of drain plugs. And if left where the maker installs them, the lube service man will have a tough job. In a sizeable plant you are dealing with many barrels of oil, most of it above 300 ssu at 100 F. To appreciate the time element, check how long it takes to pour five gallons of such oil through a ¾-in. ell. You will find this simple step accounts for a big chunk of man-hours.

Now consider one way to bring this problem under control. First, convert each drain plug to a standard outlet valve. Then pipe from the valve to an easily accessible point, preferably at rear of machine (photos above). Remember, each machine, whether a 50-gal reservoir or a 2-pint ring-oiled bearing, presents the same problem to a varying degree. Your next step may well be to build a pump and stand as shown above. This shop-made design came about after experimenting for many years with the problem.

Use 20 ft of hose on the outlet and another 20 ft on the suction, giving you a 40-ft operating range. Now oil barrels can be left in the aisle and several machines serviced from one location. Using the old method, your men might well move a ½-ton in pans, chucks and fixtures to get at the drain. With this setup, time needed to drain, flush and refill 20 machines may often be reduced to 1/20 that for a straight hand operation. Only one connection to each machine is needed since the machine hose is changed from inlet to outlet by switching valves on and off. How much time will this setup save? In one plant, one man in an 8-hr day drained, flushed, refilled 50 mills.

Hand trucks are unglamorous in the plant production pattern. Even though great strides have been made in conveying and automating, many plants still have the maintenance problems that go with hundreds of hand trucks. As many as 25 or 30 can be found in a single department, often under no maintenance man's specific supervision. Sure, the wheels are inexpensive and easily replaced. But on more than one occasion a sticking, skidding hand truck has caused product damage over $1000, plus severe personal damage.

It may appear as a small point, but one practical way to handle the problem is to periodically station a service man in production area and have truck pushers roll their trucks in and flip them over for checking. Wheels can be tagged for replacement at the same time.

Electric motors are common to all industry, large or small. It's not difficult to find 10,000 motors in a plant. And each maker has gone to considerable trouble outlining the proper procedure for lubricating his product. Fortunately, they all pretty much agree on the lubricant type. This is one area where the more costly oil or grease is most likely to prove least expensive. Any extra time spent applying it will be on the saving side of the ledger. You could profitably take the time saved in draining, flushing and refilling production equipment and apply it to better electric-motor maintenance.

To date there is no practical way to lubricate motors from a central system. With exception of the lubricated-for-life motors, each must be dealt with individually. Accurate records and schedules are the best answer after the most stable oils and greases are selected.

Lube scheduling is a variable. Look at the scheduling part of the lubrication picture by simply injecting the time element: *when* lubricant should be applied to each bearing, *when* lubricant should be replaced and housing flushed, *when* filters should be changed, etc.

To drive this point home, consider a working schedule in many plants having a minimum motor-downtime record. They are evolved, like other bits of practical knowledge, from studying

(*Continued on page* 216)

Treatment of water used for condensing, service, evaporator makeup, drinking

Do you know how to tell if condensing water is corrosive or scale-forming? How to clean service-water pipe? How to get carbonate breakdown? The author gives these answers, and more

By D C SWIFT, *Ebasco Services Incorporated*

► WATER FOR SPECIALIZED USES often needs special treatment. Here's useful information on treatments for four important plant waters.

CONDENSING WATER

Chemical treatment of condensing water taken from ocean, river or large lake and used just once in the condenser generally costs too much to be practical. If water is corrosive or otherwise undesirable, use resistive materials for tubes and protective coatings for piping and condenser waterboxes. Intermittent chlorination prevents or retards growth of algae and sea-water crustaceans.

Where condensing water is recirculated, cooled and reused, treatment may be desirable, particularly if concentration makes the water scale-forming. In cooling, conduction and radiation transfer part of the heat to the air. But most of the cooling results from evaporation.

In a condensing plant, evaporation roughly equals the pounds of steam condensed. In a lake or reservoir, natural inflow and overflow usually prevent significant increase in solids concentration caused by evaporation.

Also, in a spray-type cooling pond, spray carried off by the wind usually prevents much of a concentration build-up. In cooling towers, however, spray eliminators are often used and little water is lost (probably not more than 0.1 or 0.2%). Concentrations tend to rise to troublesome levels.

Surface waters, unless badly polluted, are fairly well stabilized. They do not ordinarily cause deposits on the condenser surfaces unless the water is concentrated several times. If makeup supply permits a blowdown equal to or greater than the evaporation from the tower, you should have little trouble.

Well waters seem more prone to cause trouble, probably because dissolved-solids concentrations are higher. As a minimum treatment, use preliminary aeration and settling.

Depending on water characteristics, softening, acidification or deionization may be indicated. Large quantities are required for makeup, so treatment and equipment must be fairly inexpensive. The better and more complete the treatment, the less blowdown and higher tower concentration permissible. Ideally, strike a balance between treatment costs and makeup water to give lowest overall water cost.

The Langlier Index or one of its variations helps you calculate a water's tendency to corrode or deposit scale. You need to know temperature to which water will be raised, pH, total solids, calcium hardness, and total alkalinity. Using the Langlier calculating curves, you get a value of plus (scale-forming) or minus (corrosive) tendency.

The higher the water temperature, the more scale-forming it becomes. But if it is considerably on the minus side, increased chemical activity caused by the higher temperature may increase corrosion before scale begins to deposit. Moreover, with low total solids or calcium content, the protection calculated by the Langlier Index may not actually be present.

Several variations of the Index have been proposed to show questionable areas where protection is not complete. But the Langlier Index is a useful tool when intelligently used.

Because you need a fairly strong scale-forming tendency to lay down a thin uniform scale for protection, a positive index of 0.5 to 1.0 is usually recommended. This means that actual pH should be 0.5 to 1.0 points higher than pH as determined by the Index.

Make or correct the water analysis and pH measurement to 20 C (68 F). Langlier's formula takes into account the pH variation as temperature rises. Checking the Index at heat-exchanger inlet and outlet may be revealing if temperature rise is considerable.

As a general rule, remember that scale can be removed by mechanical or chemical cleaning. But corrosion damage is hard to repair except by costly replacement.

Materials in the condensing-water system also have a bearing on water treatment. Condenser tubes are made

of a rather noncorrosive material. So watch for corrosion at tube sheets and heater boxes or steel condensing-water pipes. With concrete or cast-iron pipe, protect waterboxes and tube sheet with a good protective paint.

Because it is difficult to hold an exact index of water condition and also because the desired positive index is not surely known, check condition of metal surfaces through the condensing system frequently. Maintain protective coatings in good condition. Relatively small exposed areas often corrode more rapidly than an entire unprotected area.

You may find scale on the condenser tubes. This interferes with heat transfer. Comparing present heat transfer with original or guarantee conditions indicates the extent of deterioration.

Check average heat transfer by subtracting outlet circulating-water temperature from hotwell temperature. This is known as the terminal difference. If it is between 5 and 7 F, assume that condenser tube surface is in good condition.

But use this quick check with caution. An old-type condenser may have considerable condensate refrigeration, giving a false indication of good heat transfer. In the opposite direction, where outlet circulating-water temperature is quite low—say, below 70 F—a terminal difference up to 10 F may be found quite satisfactory.

Inhibitors are often used in closed condensing-system water treatment. They give some protection if Langlier Index varies from the optimum. Inhibitors like sodium hexametaphosphate prevent scale deposition and corrosion over a few points range in the Langlier Index.

Controlling inhibitor concentration is not too difficult or critical. A few ppm give protection, and inhibitor can be added once a day or intermittently to maintain a specified value. Follow manufacturer's recommendations.

pH control. With some waters you get an undesirably high pH as the water concentrates. Keep this down by (1) feeding sulfuric acid (2) burning raw sulfur to form SO_2. When combined with water SO_2 forms H_2SO_3 or H_2SO_4 (3) blowing a portion of spent boiler flue gas into the water system. The water absorbs the CO_2 and SO_3 from the flue gas. Analyze water at least once a day, particularly if plant load varies.

Adding sulfuric acid or SO_2 involves serious problems of corrosion and water-quality stratification. Give thought to the point and method of adding acid to avoid corrosion.

Mixing portions of the sulfur-burning or flue-gas-mixing apparatus may also be subject to corrosion. A low pH condition usually results before dilution is complete. To avoid this have plenty of water flow past the mixing point and use corrosion-resistant material in low pH portions of the circuit.

Sulfur-burning installations usually cost less to install and operate, and are less hazardous than acid-using setups. But you may have to pay more attention to operation and maintenance; and there is also the fire hazard.

Flue-gas-using installations are economical if gas connections are not too long. Operating costs are low. Dust entrained in the flue gas may cause deposits in low-velocity portions of the condensing-water circuit. But aside from cleaning out this material during overhaul, no trouble should result.

In installations with low stacks and cooling towers set close to them, tower-water pH may lower noticeably when flue gas is blown into the tower inlets. This unpredictable effect makes regular checking of cooling-tower or spray-pond water desirable.

Cooling towers. Redwood or cypress cooling towers have maximum resistance to rot and delignification. But in a few cases rather serious wood deterioration has occurred. This is thought to be caused by the type of water flowing over the tower. Maintaining pH below 8.3 helps, but other factors evidently have a bearing.

An appreciable amount of free causticity may dissolve some of the lignum in the wood, leaving the cellulose fibers more or less open to decay.

Brass and copper nails, bolts and fittings are generally used in wood-tower construction because they don't rust. But the larger fittings and elements requiring considerable strength may be steel or cast iron.

A brown rot, apparently caused by iron bacteria, often forms where water seeps in between the metal and wood. This weakens the wood and the rot may spread to adjacent timbers. Chlorinating tower water helps prevent growth of the iron bacteria. Where brown rot has started, keep it from spreading by replacing elements.

Portions of a tower exposed to alternate wetting and drying may quickly deteriorate from cracking, splitting and weathering, but this is more a matter of water flow and tower design than of water conditions. Sometimes you can alter water flow paths slightly to keep a tower section continuously wet or dry. Idle towers may deteriorate faster when they are wetted down periodically, but this reduces the fire hazard.

Prevent algae growth by regular chlorination. Accumulations already formed may crack off if allowed to dry. If not, remove them where they destroy even water flow.

SERVICE WATER

Requirements for treating service water are much the same as for treating closed-system condensing water. Algae growth is not usually a problem, so omit chlorination unless the water is also used for drinking and sanitary purposes.

Temperature rises in heat exchangers, like oil and hydrogen coolers, are usually from 30 to 50 F instead of the 10 to 15 F in a condenser. This makes it harder to condition the water.

Piping for service water is usually steel. And it is generally impractical to coat the pipes against troublesome internal corrosion. So it is almost always better to err toward the scale-forming side in conditioning service water.

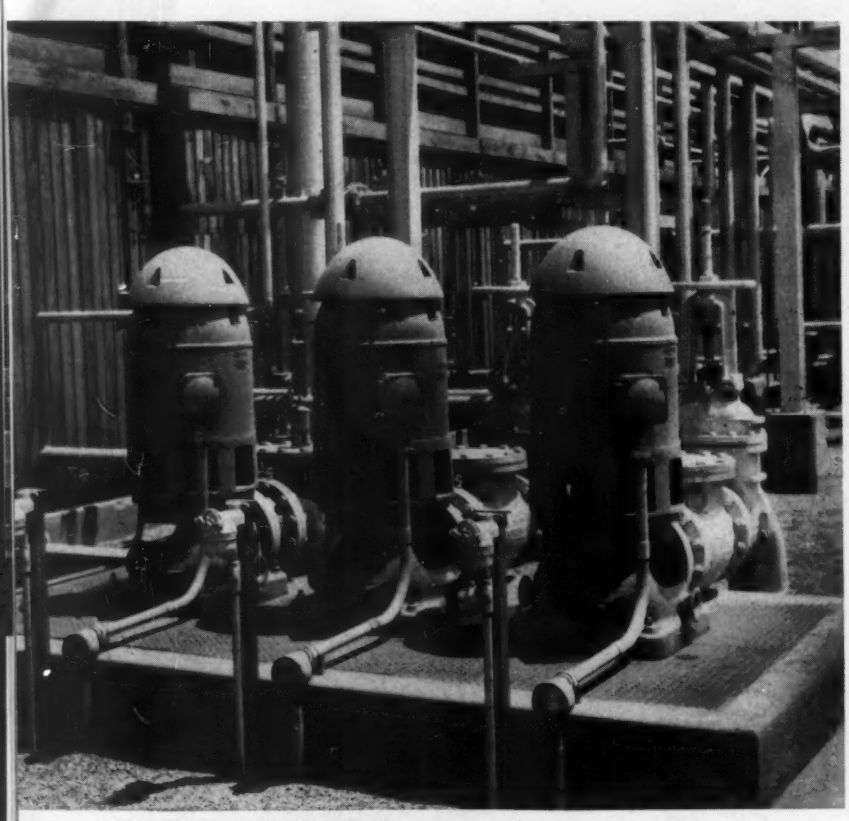
Corrosion forms tubercles on steel surfaces. Oxygen in the water reacts with the iron in the pipe to form iron oxide. This occupies a much greater volume than the original iron, sometimes plugging a small pipe completely. Even in larger pipes the roughened surface may retard water flow and increase pressure loss.

When rust plugs the pipe, corrosion reduces wall thickness. Since small pipes have thinner walls they are usually the first to develop leaks.

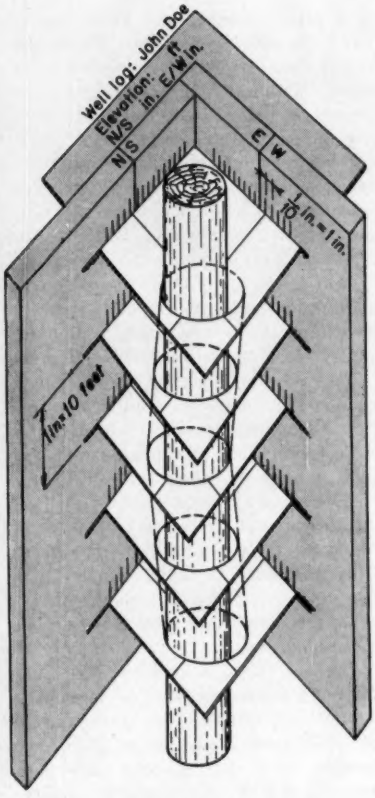
Best prevention: don't let a corrosive-water condition develop. Once corrosion tubercles form it is hard to stop them. Even though the water is later brought to a noncorrosive or even a scale-forming condition, action continues in corrosion cells previously formed on the pipe walls.

Cleaning methods. Mechanical or chemical cleaning removes iron oxide or scale deposits. Usually piping has to be taken down and the various sections rodded out individually. Another cleaning system uses "rattlers" that vibrate the pipe hard enough to loosen at least some of the deposits.

(*Continued on page* 210)



THREE VERTICAL TURBINE PUMPS serving cooling tower. Units of this type are popular today in cooling-tower service because they offer many real advantages



1 Sugges tedmethod of keeping a well log and checking it for crookedness

12 design pointers on using vertical turbine pumps in industrial plants

By R H BIRD, *Designer, Peerless Pump Div, Food Machinery and Chemical Corp*

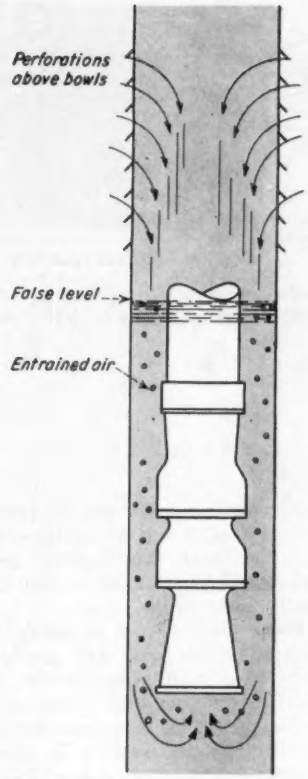
► BEFORE DRILLING A WELL, the probable characteristics should be obtained from available data on nearby wells. Give careful attention to the factors of depth, diameter, screen size, sand production and the general perviousness or stability of strata that might contribute to the well's collapse if production were excessive.

Be sure to determine the chemical quality of the water. The pH and presence of carbon-dioxide gas are somewhat a measure of corrosion and may dictate special materials for the pump. Further, the presence of iron or surface contamination of the water affects the potability and usefulness unless there is some chemical treatment prior to use.

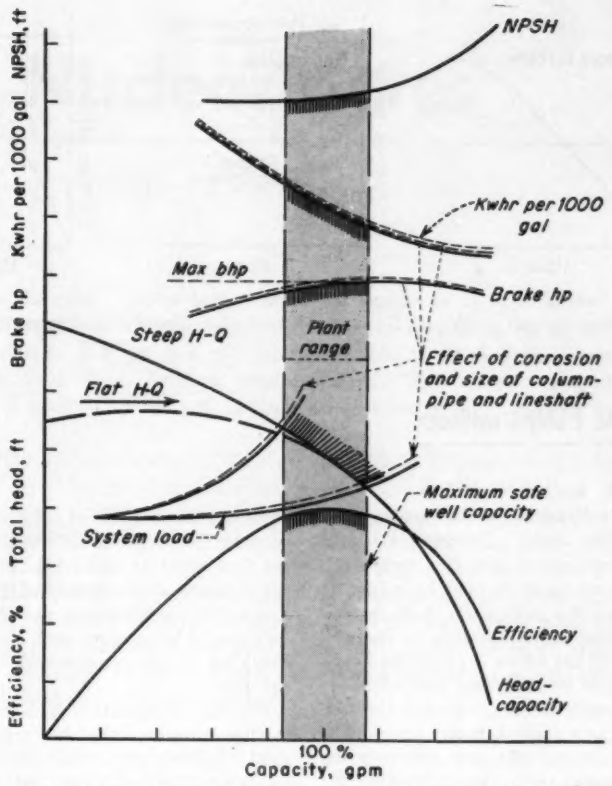
Well log. The usual graphic method of plotting the log of a well in north-south and east-west planes gives at best a distorted view of the crookedness or vertical misalignment. The use of a slotted frame, Fig. 1, having adjustable cards will show the 3-dimensional condition of a well. The usual log data are used and the cards representing the well opening at various elevations are kept on file. A piece of wooden dowel of proper scale to represent the maximum pump and column diameter can be inserted through the series of card openings and points of interference determined directly. On this basis the proper location of column-aligning spiders can be fixed to assure a straight line shaft.

When the well perforations are above the pump bowls, there will be objectionable air entrainment. This leads to a false water-level datum being registered. The false level includes the velocity head and friction losses around the pump bowls, Fig. 2.

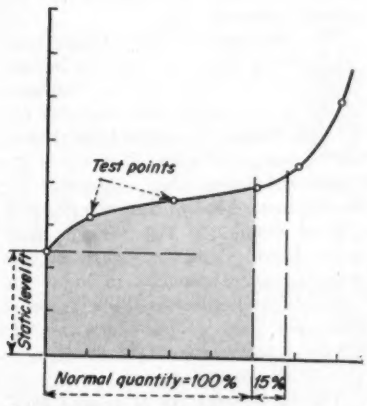
Production characteristics of the well are as important as those of the pump and sufficient test data should be taken to define the various pumping levels



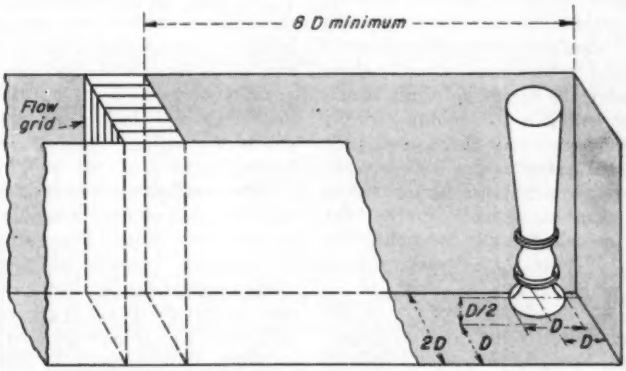
2 False water level can be caused by well perforations above pump bowls



3 Typical performance of a vertical turbine pump in terms of its capacity. A plot of this type is helpful in operating a pump



4 A well production plot can be an aid in efficient operation of the system



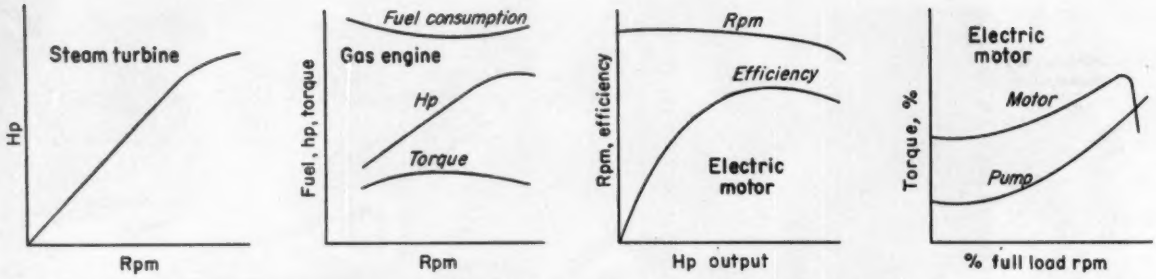
5 Suggested sump form for a vertical turbine pump. For best suction flow, manufacturers recommend only one pump per sump

from the static through the normal range and into the breakdown region. A well production plot, Fig. 4, greatly aids in operating the pumping system. Good wells are expensive and require proper care to avoid overpumping, resulting in sanding or collapsing.

For supply sources like rivers and lakes, there is small change in the pumping levels and the sump becomes an important component that should be designed on the basis of scale-model tests. A screen or trash rack is sometimes required and allowance must be made for periodic cleaning and inspection. Fig. 5 shows a suggested sump form. One pump per sump is preferred.

Pumping unit. Because the pump choice is important from several aspects use should be made of the engineering resources and experience of a reliable and well-established manufacturer. Pump-performance characteristics must be carefully fitted into the total plant requirements. These vary widely in industrial applications. A steep head-capacity curve may be quite suitable with fluctuating well levels, but the system-head of a processing plant may require the flat type of curve for which the pressure would not be excessive when valves are closed.

Usually, the manufacturer determines



6 *(a)* Typical curve of hp vs rpm for steam turbine driving vertical turbine pump. *(b)* General performance characteristics for internal-combustion engine drive. *(c)* Electric motor's efficiency for pump drive. *(d)* Typical torque for pump, motor

TURBINE PUMPS continued

the bowl diameter for the nominal well size, with proper allowance for sufficient clearance to give free entry. But in extreme cases it may be advisable to choose the next lower nominal size when there are deformities in the well or some of the inflow is above the bowls. There may be a further limitation due to the restrictive production of the well suggesting a lower-capacity pump. The initial cost and efficiency of two pump sizes should be compared over the amortization period in terms of power cost.

Performance. Fig. 3 shows the usual pump performance in terms of capacity. Choice of the normal pump capacity (100%) should be made with respect to the normal well quantity, which is about 15% below the beginning of the breakdown region. It is desirable to have the maximum horsepower of the pump near the normal quantity. For high-capacity pumps where the shutoff horsepower is higher than at normal capacity, the engine or motor must be sufficiently oversize, or protected by devices to stop the pump or bypass the flow.

Since the head and pressure of the pump are directly indicated by gages, the plant operator sometimes finds it more useful to have the efficiency of the pump and total system plotted against head instead of the usual coordinate of capacity. In this way the effects of wear and corrosion, as well as the loss of efficiency, are more readily observed.

Efficiency. As an example of operating costs in terms of changing plant efficiency, assume a 5-year amortization period (21,600 hours at 12 hours per day), a power cost of 1.5 cents per kwhr and a nominal pump load of 100 bhp. With 91% motor efficiency, the plant requires 1,773,000 kwhr at a cost of $26,600. If plant efficiency falls from 75 to 74%, the operating power cost would be increased $350 for this one-point drop. Such an index could be used in the proper multiples to decide the best point to make repairs or the replacement of obsolete equipment. If Federal-power allocation and conservation should be applied, such a check of changing performance would be quite valuable.

For engine operation it is advisable to choose a pump that has nearly constant efficiency at normal capacity for the expected speed range. Selecting an engine with adequate service factor for continuous duty is of extreme importance.

To enable the plant operator to limit the range over which any one unit of a group of pumps should be allowed to run, it is suggested that the power quantity of kwhr per 1000 gallons or the equivalent fuel consumption be plotted for various capacity rates and heads, Fig. 3.

Some applications require the pump to be capable of reverse rotation without excessive speed. From studies on the transient behavior of pumps the runaway speed can be determined. For common pump types it is generally not sufficiently high to damage either pump or motor. In passing, it is noteworthy that the modern pump is almost as efficient when operated as a turbine, as it is when run as a pump.

Cavitation characteristics of the pump must be considered if safe operation is expected for restricted suction conditions. If the plant operating range could be narrowly controlled, it would be possible to choose the pump that would run near the threshold of cavitation with maximum efficiency. As previously shown, Fig. 2, wells with some or all perforations above the bowls are a distinct handicap to a pump since the apparent water level is decreased by the velocity head and friction losses. All tend to aggravate suction conditions and induce cavitation. For unusual requirements caused by volatile liquids or high lifts, the pump manufacturer should furnish the net positive suction head (npsh) curve for the pumps.

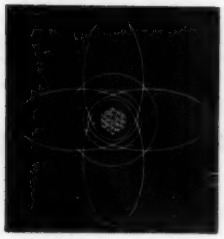
Pump unit. Choice of mechanical features in the pump unit should be made from basic considerations that clearly show functional advantages or disadvantages. The fully enclosed type impeller is well-known for its general stability during extended wear, hydraulic balance that is more favorable to the thrust bearing, and for being insensitive to axial adjustment over the normal pumping range.

The semi-open impeller allows careful finishing of the passages but is quite dependent on close running clearance at the mating surface to minimize circulation losses. Clearance is subject to fluctuation as the head changes over the range and necessitates adjustment for the maximum head with subsequent penalty of circulation loss for the minimum head. Bypassing part of the pump's normal capacity to lower the power input is done at the expense of kwhr per 1000 gallons since the efficiency is correspondingly lowered as circulation losses increase.

The further feature of raising semi-open impellers to develop a well during the sanding phase and reseating after this or after normal sand wear is offset by the spiral type of erosion in the mating surface, which is not fully resurfaced by readjustment except at the expense of impeller port width. This loss of capacity registers in the increase in kwhr per 1000 gallons.

Column. In choosing the pump column two general types of construction should be considered. The enclosed line shaft with proper seals at the bowl connection can be lubricated with oil and supported in close-fitted bronze or

(*Continued on page* 200)



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Nuclear liability insurance to be offered by Government may soon be a reality. Joint Committee on Atomic Energy has approved legislation to make the Government good for $500-million liability per plant in reactor disaster. This would augment the $65 million per plant covered by the private insurance industry.

Atomic energy course for management, Oct 1 to 5, 1956 at Biltmore Hotel, New York, N.Y., is offered by The National Industrial Conference Board, 460 Park Ave, N.Y. 22, N.Y. This 5-day course covers exactly the same lecture material given in their 7-day course: Registration fee $190 plus $23 for luncheons.

Trade fair of atomic industry will be held Sept 24-28, 1956 at the Navy Pier, Chicago, Ill., sponsored by the Atomic Industrial Forum, Inc, 3 East 54th St, New York 22, N.Y. A 3-day conference on "Management and technology for atomic industry" will be held concurrently at Morrison Hotel, Chicago, Sept 25-27. For trade fair tickets, complimentary, write Forum on your letterhead.

AEC licenses must be obtained by anyone having special nuclear material, source material and byproduct material. The special nuclear material consists of U-233, uranium enriched in U-235, plutonium and other material the AEC so designates. Source material includes natural uranium and thorium. Only the Government may own special nuclear material, but anyone can own source material. Byproduct material consists of radioactive isotopes produced in nuclear reactors.

AEC regulations on materials and facilities require that: (1) A licensee or his staff must have suitable training or experience to possess and use the material safely for the purpose requested. (2) His equipment has to be adequate to protec health and minimize danger to life and property. (3) The location of proposed use must be suitable for the purpose. (4) He may use the material only for the purpose authorized in his license. (5) He may not transfer the material or facility except to a person authorized by special or general license to receive it.

Booming uranium mining operations make USA the Free World's leading producer. In 1948, USA known ore (U_3O_8) reserves were barely 1-million tons. These had been developed for vanadium production. After mining millions of tons the indicated reserves today are over 30-million tons. Potential reserves of the producing areas add about another 30-million tons. Large areas of USA with favorable geology have not yet been explored for uranium ore deposits.

Uranium ore production in USA ran about 70,000 tons in 1948. Today's ore production rate reaches nearly 3-million tons per year and is expected to grow in the future to 6-million tons per year. Nine mills handle today's production, three more mills will start this summer. By 1958 number of mills may be doubled. Mill capacity ranges from 200 to more than 2000 tons of ore per day. Government will probably be predominant buyer of uranium for another ten years.

Free neutrinos found after they had been predicted some 20 years ago. These extremely tiny particles with no electrical charge and smaller than an electron are emitted at the same time as a negative electron during beta decay. Team of Los Alamos scientists detected them in elaborate experimental setup. Despite billions passing through only a few per hour are captured in detector.

INSULATING CONCRETE being poured over underground piping

Insulated pipe vs uninsulated: the

UNINSULATED PIPE may be suitable where heat gain is small

Easy calculation of insulation for

By HARRIS H LEVEE
Mechanical Engineer, Gibbs & Hill, Inc

► RECENTLY, THE AUTHOR had to make a recommendation on whether it was necessary or economical to insulate several miles of buried underground chilled-water piping. This piping carries chilled water at various temperatures from a central supply point to many buildings.

Problem. If the heat gain into the buried bare chilled-water lines was greater than the planned excess capacity of the plant, it would be necessary to provide either additional refrigeration equipment and auxiliaries or insulate the underground lines. If either the plant refrigeration capacity had to be increased or the long lines insulated, there would be a considerable increase in plant cost not originally allowed. Thus the heat-gain (temperature-rise) calculation for the bare pipes was extremely important.

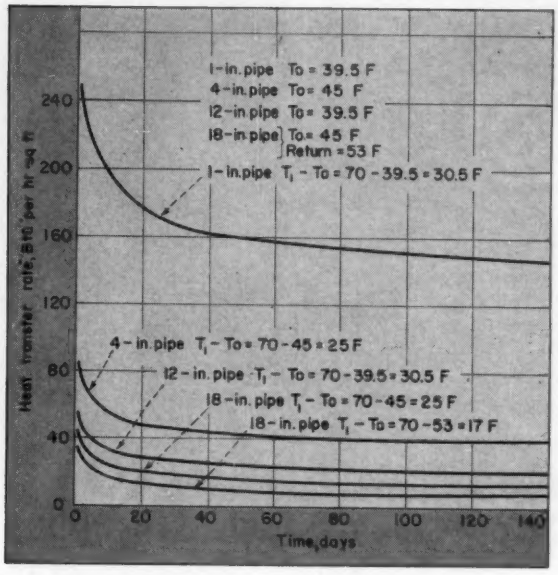
Investigation showed very little work had been done in this field. Various manufacturers of insulating materials and the Industrial Mineral Fiber Institute were contacted, but they had never handled a problem of this type. Several professors specializing in heat transfer were unable to advise the author as to the best method for calculating the heat gain and consequent temperature rise of the water. They concurred, however, on the method used to solve the problem as being an approach to a true solution.

Method of approach. Insulation requirements for buried lines carrying a fluid at temperatures below ground temperature appeared unique. No data specifically covering this problem could be found. Therefore, it was the author's opinion that the heat-pump theory could be extended to cover the case in point.

Major difficulties met by theoretical treatment of the subject are: (1) Knowledge was lacking of the thermal conductivity and diffusivity of the soil at the plant, and specifically in the pipe locations. (2) Moisture migration from the warmer (surface) to the cooler (underground) regions in the soil improves the conductivity around the buried pipe and produces a less favorable condition for the installation. (3) Below-ground temperatures were unavailable and would have to be taken throughout the summer, a minimum time to achieve stability, to be of much value in any analytical treatment. This was impractical. The time element did not permit exhaustive tests because plant construction was proceeding at a highly accelerated pace.

Site data. There is no ground-water

heat-transfer rate found by using these factors is the key to solution


1-in. pipe To = 39.5 F
4-in. pipe To = 45 F
12-in. pipe To = 39.5 F
18-in. pipe To = 45 F
Return = 53 F
1-in. pipe T1 - To = 70 - 39.5 = 30.5 F
4-in. pipe T1 - To = 70 - 45 = 25 F
12-in. pipe T1 - To = 70 - 39.5 = 30.5 F
18-in. pipe T1 - To = 70 - 45 = 25 F
18-in. pipe T1 - To = 70 - 53 = 17 F
Heat transfer rate, Btu per hr per sq ft
Time, days
0
40
80
120
160
200
240
0
20
40
60
80
100
120
140

HEAT-TRANSFER RATES for various pipe sizes and temperatures

Values for heat-transfer calculations

$P = 1$ (pipe surface)

Z	G(Z,P)	Z	G(Z,P)
0.10	0.049	5	0.217
0.20	0.067	6	0.228
0.30	0.080	8	0.247
0.40	0.090	10	0.263
0.50	0.099	12	0.275
0.60	0.107	15	0.291
0.70	0.113	20	0.312
0.80	0.118	25	0.328
1.00	0.128	30	0.342
1.20	0.137	50	0.380
1.5	0.148	100	0.433
2.0	0.163	500	0.560
2.5	0.175	1000	0.614
3.0	0.186	5000	0.742
4.0	0.203	10000	0.797
		25000	0.870

underground chilled-water piping

problem in the area above a depth of 100 feet. The soil consists of a few feet of top soil followed by a hard crust of sandy clay to a depth of 20 feet. Soil weight is 98 lb per cu ft.

The average natural water content in the soil is approximately 20%. However, just what this is during the summer, when the surface is the hottest, is unknown. Presumably, it is less than 20%.

Assumptions. Calculations are based on the worst case—that is, using a soaked sandy soil having a high thermal conductivity. The pipe water film, pipe wall and exterior pipe coating of asphaltum are considered to have no resistance to heat flow. A reasonably high initial below-ground temperature is assumed.

Reference data. The thermal conductivity of the soil was found to vary as in the following tabulation:

Soil	k
Moist clay, 24-in. cover	0.4 – 0.6
Moist sandy, 24-in. cover	0.5 – 0.6
Soaked sandy, 24-in. cover	1.1 – 1.3

The only data available for similar climatic conditions were for the Amarillo, Texas area. These were used. Temperature 3 ft below ground at Amarillo, Texas varies between 42 and 70 F. Since Amarillo had a greater prevalence of sunlight and a higher air temperature in the summer than the plant site, it was assumed that using 70 F as an initial below-ground reference point was on the safe side.

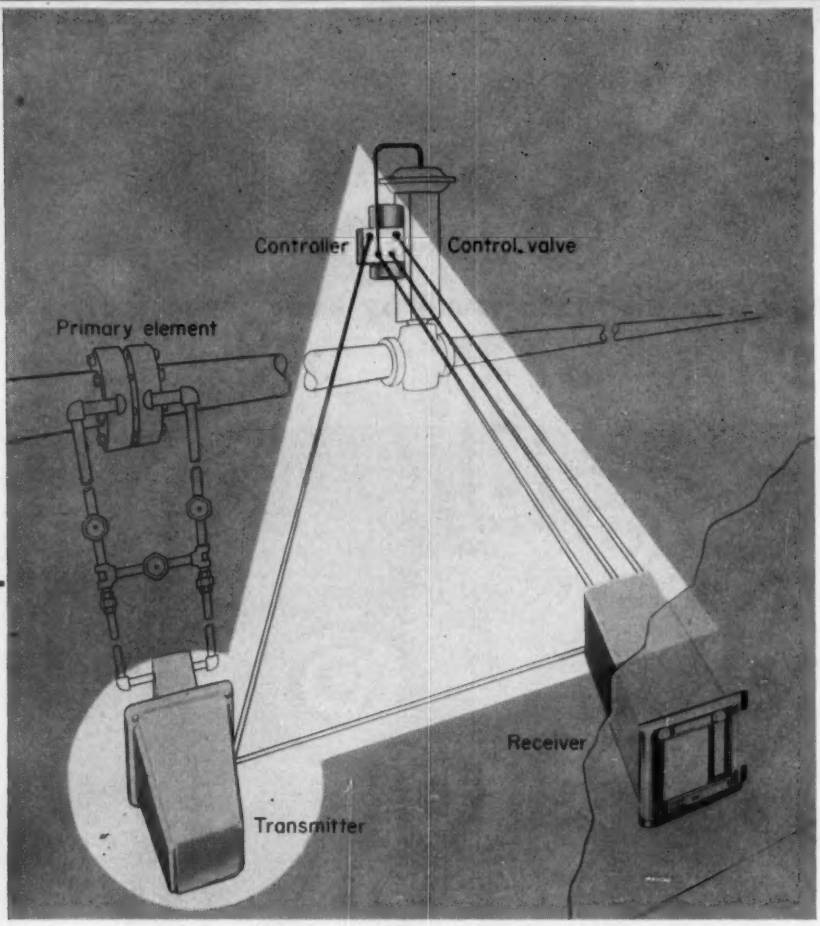
Formula. This is: $T_1 - To = \frac{2\pi RWG}{k}(Z,P)$ An extension of the theoretical line source equation, this has appreciable error when applied to pipes large than 4-in. diameter or for long-time periods. The formula covers a pipe transferring heat at a rate of Q' (see symbols below) when the temperature differential between the initial soil temperature and the point under consideration (pipe surface) is $T_1 - To$.

The values of $G\ (Z,P)$, which have been computed for a wide range of values of Z and P, were found in the literature. Computation for $G\ (Z, P)$ is a complex integral calculation, beyond the scope of the present article.

Symbols and values. a = thermal diffusivity = k/pc; p = density, pounds per cubic foot = 98; c = specific heat, Btu per lb per deg F = 0.45; k = thermal conductivity, Btu per hr sq ft F per ft = 1.2; q = rate of heat flow, absorption, Btu per hour; Q' = rate of heat transfer, Btu per hour per linear foot of pipe; $Z = at/R^2$; $P = r/R$ ($P = 1$ when applied

(*Continued on page* 198)

By M R SKROKOV
Field Engineer
Taylor Instrument Companies



Second article in a series on flowmetering

Flow transmitters

► FLOW TRANSMITTERS convert pressure differences representing flow rate into proportionate pneumatic or electric signals that can be transmitted to remote receivers or controllers. Flow transmitters are the second stage in the flowmeter and control circuit. Primary elements, the first stage, detect difference in pressure resulting from rate of flow. Primary elements were discussed in the first article of this series (POWER, February, pp 100-103). Other units in circuit are receivers, controllers and control valves.

Pressure difference from primary element is sufficient to drive indicator if near primary element. But if indicators, recording instruments and control valves are to operate at a considerable distance, the signal must be amplified. This the flow transmitter does with high accuracy for distances of hundreds of feet. (Where thousands of feet are involved we employ telemetering instruments, which are somewhat different from the transmitters discussed in this article.) *Transmission lag* includes time lag from primary element, response of transmitter, and lag in transmission lines from transmitter to receiver or controller. In usual flow-transmission and control systems, overall transmission losses average one percent of range of instrument doing the controlling. Accuracy, therefore, is of chief concern when considering controlling instruments. The transmitter, however, should be as close as possible to the primary element to pick up primary differential pressure with minimum transportation lag.

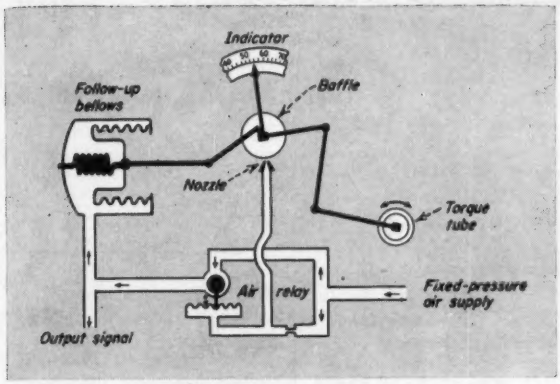
Four basic arrangements of the transmitter relative to other units in the flow-transmission system are available to instrument engineers. In control circuits the difference is mainly in location of controller.

1. *Simple transmission of measurement.* There is no controller. The transmitter sends a signal to receiver, which indicates or records flow as a function of pressure differential. An indicator may be part of transmitter, or transmitter may be "blind," as is often desirable where ease of mounting and saving space are factors.

2. *Transmission of measurement with control from receiver.* Transmitter sends signals to receiver, which is located remotely on a panelboard. The controller is built into receiver case or closely associated with it. Controller operates control valve, which is at another remote location. Receiver indicates or records measurement, and transmitter may be indicating or blind.

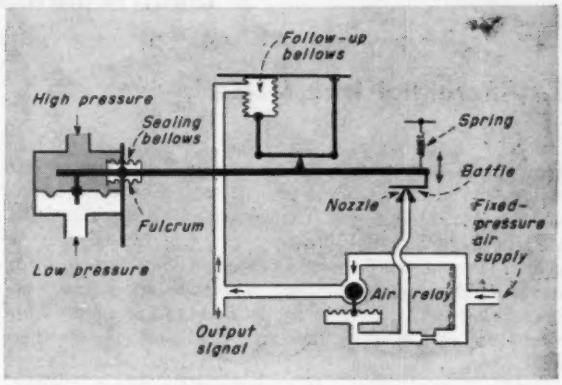
3. *Transmission of measurement with control from transmitter.* Transmitter output signal is fed directly to receiver on panelboard, and also to controller mounted in transmitter case. Signal from controller is sent to control valve.

Pneumatic transmitters are sturdy, versatile



1. Torque-tube transmitter

Differential pressure from primary element moves an aneroid manometer in a sealed enclosure mounted on back of transmitter. Motion is brought inside instrument through torque tube. Rotation of torque tube with variation in pressure drives indicator (if used) and moves baffle with respect to nozzle. Nozzle-baffle relationship determines air back-pressure that actuates air relay. Air is supplied to relay at 20 psi. Pressure of output air signal varies in proportion to original pressure differential from primary element. Instrument amplifies signal many times, making it possible to transmit flow rate to remote receiver. Output signal is also fed to bellows. This, acting through mechanical linkage as a follow-up mechanism, prepares instrument to respond quickly and accurately to next change in flow rate. Torque-tube transmitters are preferable to beam types where transmission pressures are lower than 20 inches of water.



2. Beam transmitter

Difference in pressure from primary element is applied across diaphragm that bends down with increased pressure differential. The beam is pivoted on fulcrum in center of sealing bellows. Since end of beam is attached to diaphragm, beam moves up and down along with it. Opposite end of beam has baffle attached that works with nozzle to create backpressure to air relay. Air relay functions in same manner as with torque-tube design to give amplified output signal. Follow-up bellows is used to reposition baffle relative to nozzle so that it will be ready for next instantaneous change in primary differential pressure. This bellows, plus loading spring and fine and coarse adjustments on knife edge, enables beam transmitter to achieve fast speed of response and greater accuracy than torque-tube designs. Beam types are smaller, are blind, and cost less initially. They are suited to transmission ranges of 20-200 and 80-800 inches of water.

A variation of this arrangement has a control point setting station mounted on panelboard in association with receiver. Controller can then be adjusted from panelboard instead of from transmitter, which may be inconveniently located.

4. *Transmission of measurement and control signal with controller on control valve.* Measurement is indicated or recorded at receiver on panelboard. Control-point setting station can be mounted on control panel, as in scheme illustrated on opposite page. As control applications have become progressively more complicated, mounting control setting station on panel has become general practice.

Choice between above arrangements depends on size power or process plant, and number of instruments on panelboard, as well as cost factors involved.

Transmitters are manufactured in a variety of designs, some using pneumatic transmission and others electric transmission. Two popular pneumatic types, which represent basic designs, are described at top of this page. Six electric transmitters are discussed in the pages that follow. Each type is especially adaptable to a particular job, and the instrument engineer may find further adaptations to fit special requirements of individual system.

Pneumatic transmitters have a longer history than electric transmitters, and are still most popular for general applications. Pneumatic transmitters were developed to meet needs of flowmetering systems that came with broadening of instrument applications in process and power industries. Size, accuracy and speed of response of present-day pneumatic transmitters enable them to do a good job. Pneumatic transmitters have an advantage over electric types where throttling action is required of control valves. Pneumatic throttling valves, economical and easily obtainable, can be operated directly from pneumatic flow transmission system. Since practical electric throttling valves are not generally available, an electric system requires equipment to convert electric signals. Pneumatic transmitters produce linear air-signal outputs (three to 15 psi) which are transmitted by small diameter tubing for distance to 500 feet without losing high accuracy.

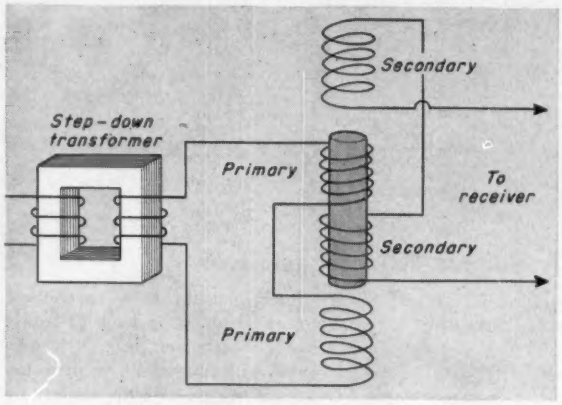
Electric transmission systems, often employing electronic feedback circuits, are used to advantage where there is tie-in with complicated process control equipment or computing systems. Applications for electric and electronic transmitters have broadened with the development of scanning and logging systems. Oil refineries and chemical plants, and atomic energy plants of the future are leaning toward systems incorporating memory circuits and tapes.

Turn page

Electric flow transmitters are gaining wider use...

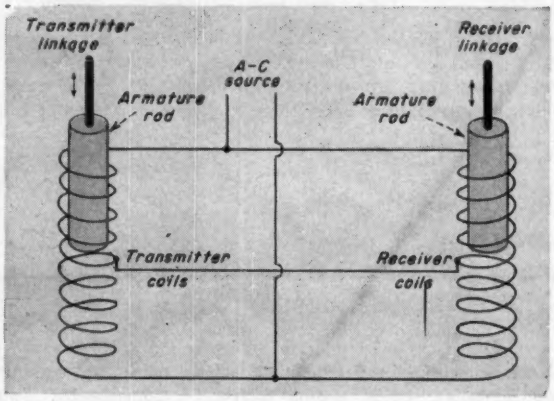
1. Differential transformer

This circuit is based on varying magnetic coupling of secondary and primary coils in proportion to mechanical movement of iron armature rod. The motion, which is proportional to primary differential pressure, can be received from a mercury-manometer float rod, aneroid bellows movement, or rotameter shaft movement. Coils of ac transformer are so arranged that one or two primary coils and two secondary coils are wound in opposite directions and buck one another. Ac current is supplied to primary windings. Magnitude of voltage produced in secondary windings depends on position of armature rod and amount of coupling produced by travel of rod. Output signal is thus proportional to differential pressure. Sketch at right shows general circuit of this type. Stepdown transformer makes it possible to operate low-voltage signal-transmission system from convenient ac supply voltage. Output signal is transmitted to receiver.



2. Inductance bridge

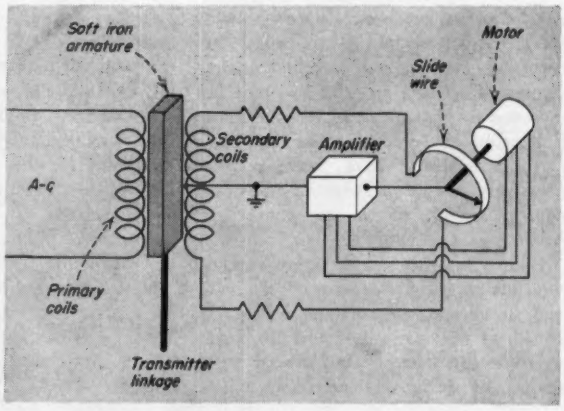
Two sets of coils, one in transmitter and the other in receiver, are connected by three wires as shown in sketch at right. Circuit is fed from ac line. Motion proportional to differential pressure is used to move a soft iron armature in primary (transmitting side) coil. Armature motion varies inductance and changes current signal to receiver coil. Soft-iron armature in receiver coil is moved by resulting magnetic field change. This movement is proportional to change in rate of flow. Unit is self-balancing without usual balancing bridge circuits. Any unbalance created by armatures being unequally located in coil pairs results in current flow through center wire. Current flow brings about rebalance by altering magnetic flux distribution until balance is achieved and current stops flowing. Armature motion in receiver coil is transmitted mechanically to operate indicator, recorder, or suitable control device.



3. Impedance bridge

A transformer with a single primary coil fed by ac has a double secondary coil, as in sketch at right. A movable armature is positioned by a manometer or other device that translates differential pressure into mechanical motion. The two secondary coils are connected into a bridge circuit. Unbalance in bridge is amplified by the amplifier, placed as shown in sketch. Amplified unbalance current operates motor, which repositions slide-wire arm, bringing circuit back into balance. Motor and slide wire are at receiver end of system. Indicator is linked to slide-wire arm and thus moves in proportion to flow-rate change.

Motor and amplifier make this unit more complicated than differential transformer and inductance bridge. Basic circuit described can be modified to operate as part of servo system with other motors if nature of flowmetering system justifies costs of complicated transmission circuits.

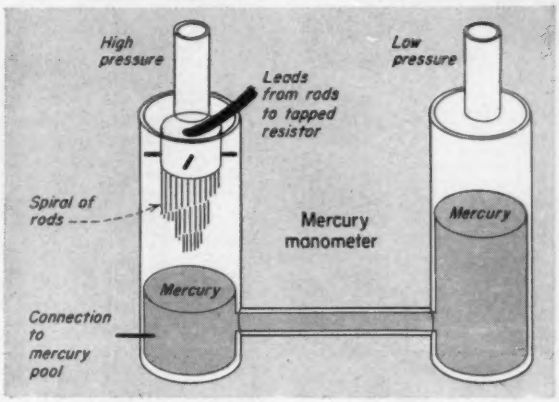


often are designed for specific applications

4. Resistance manometer

This is a unique device for transmitting level of float in a mercury manometer (Republic Flowmeters Company). It is used in conjunction with an ac balancing bridge. The transmitter consists of a spiral of metal rods that are connected to a resistor as taps. Rods are arranged in spiral to compensate for square-root relation of flow. (Refer to first article in this series in POWER, February 1956, pp 100-103.) As mercury rises in float chamber it contacts more and more rods and shorts out a part of resistance. Total remaining part of resistance is proportional to rate of flow.

Bringing ac bridge into balance at receiver can be used to give indication of flow. Resistance manometer can be used with any of several bridge-balancing techniques. Resistance manometer has advantage of small size. Also, it eliminates need for mechanical linkages in transmitter to convert differential pressure to electrical signals.

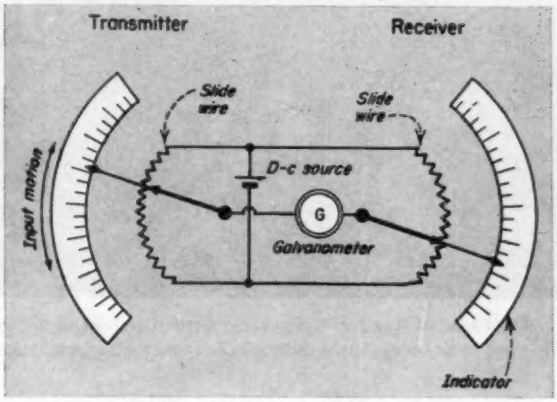


5. Wheatstone bridge

A null-balance wheatstone-bridge circuit is used in this method for indication of flow. Two slide wires are used, one in transmitter and other in receiver. Arm of transmitter slide wire is positioned automatically by mercury manometer floats, aneroid bellows or other means. At receiver end, bridge is brought into balance manually by observing galvanometer until null setting is reached. Indicator attached to arm of receiver's slide wire will then indicate flow rate on scale.

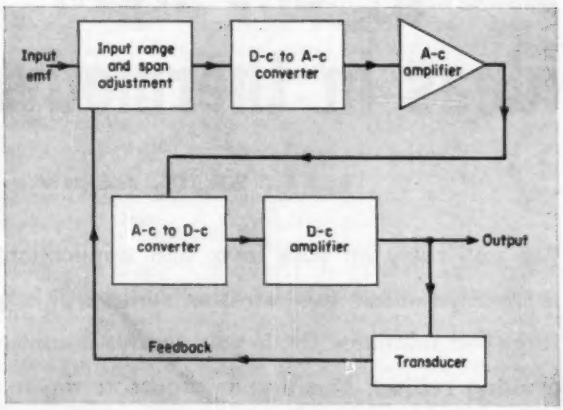
This simple system may be suitable for infrequent checks of flow rate in processes where this is sufficient. It is, of course, not adaptable to recording or control.

This method, and the four others discussed, are the most common electrical transmitting systems. Other types use synchronous motors to achieve balance, etc. For purposes of transmission or just indication of flow rate they are good techniques, and most of them can work open-close valves.



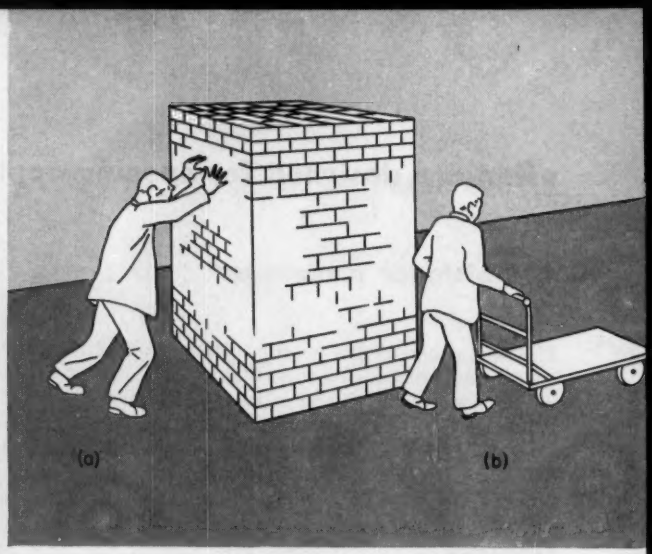
6. Electronic feedback circuits

Electronic circuits often use electric pickup circuits *1* through *5*. In another system a thyratron tube connected to inductance bridge acts as electronic sequence switch in off-on action pump control. Two basic methods are employed for scanning and logging: ac and dc systems. Ac type uses output of any ac transmitter in electronic feedback circuit on panelboard. Present dc systems use pneumatic differential pressure transmitters with converters that transduce air signals to dc signals where dc scanning and logging systems are essential for best plant operation. In temperature thermocouple systems small primary emf is sent to potentiometer transmitter where it is amplified, converted to ac for feedback purposes and reconverted to dc for scanning and logging relay circuits. Application of this technique to flowmetering can be expected. Block diagram at right shows internal circuit of typical potentiometer transmitter.

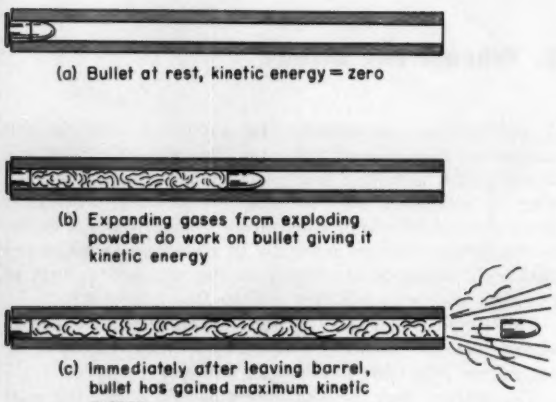


THERMO REFRESHER: NO. 1

1 Molecules of liquid in the cylinder bottom wander about in close order, while vapor molecules soar through space above



2 Force does work only when it moves object it acts upon; in (a) man does no work, in (b) man does mechanical work


(a) Bullet at rest, kinetic energy = zero
(b) Expanding gases from exploding powder do work on bullet giving it kinetic energy
(c) Immediately after leaving barrel, bullet has gained maximum kinetic energy

6 Exploding powder of cartridge produces gas that does mechanical work on bullet in gun, gives it kinetic energy

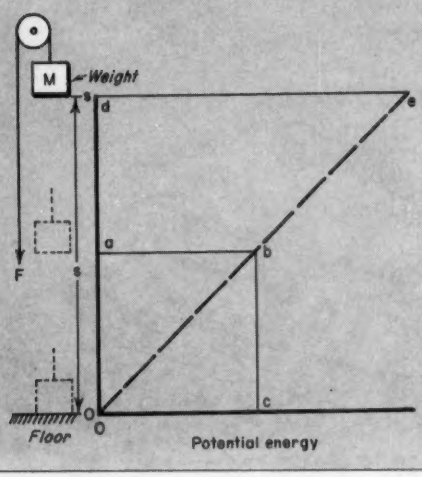
Energy and work — basic ideas in thermodynamics

By B G A SKROTZKI, *Associate Editor*

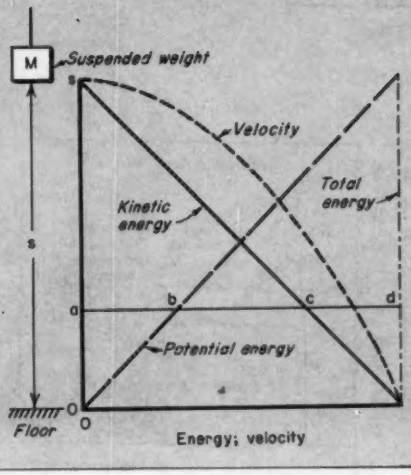
Are you rusty on your laws and applications of elementary thermodynamics? This refresher series will help you remember forgotten relations. Or, if you always meant to study this fascinating subject, here's your chance to dig in right now

► IN THIS THERMO REFRESHER we intend to cover the ground usually studied in courses on thermodynamics and heat power. We'll try to keep this as simple as possible. Sometimes we'll have to use a little higher math—but the man who's not familiar with this much math will always find an explanation that he should be able to understand.

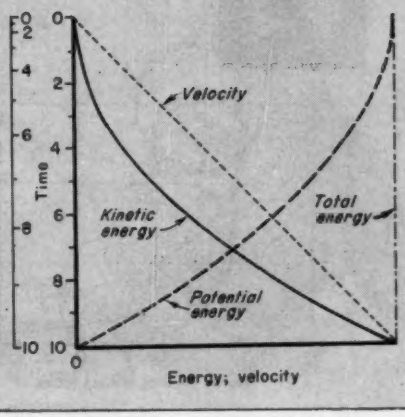
Before getting into thermo proper we'll review some of the basic physics on which the ideas of thermo are built. Thermo primarily deals with energy, which can take on many forms. We find much of the machinery we deal with really runs on principles explained by thermodynamics. This is true for: boilers, turbines, heat exchangers, compressors, internal-combustion engines,



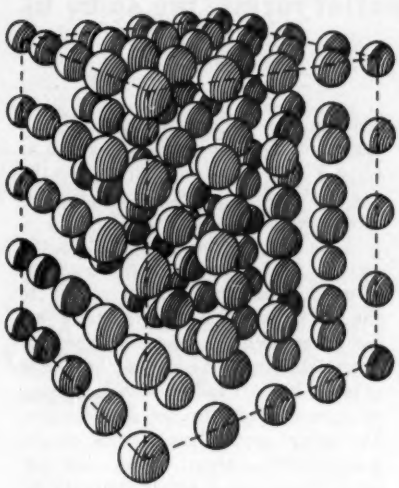
3 Suspended weight gains potential energy as it rises above floor below



4 As weight drops from position s it exchanges potential for kinetic energy

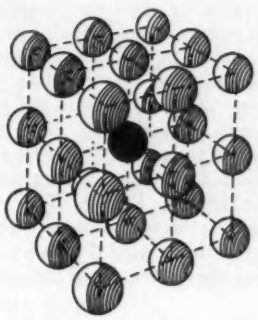


5 Falling weight's velocity increases uniformly with time, not kinetic energy

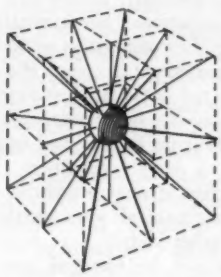


7 Molecules in a solid stand in regular order with space between each two

Kinetic molecular theory aids understanding



8 Each atom or molecule in a solid has 26 near neighbors; study center one



9 Center lines between molecule and its neighbors show force directions

refrigerating systems, heating, ventilating and air-conditioning systems, processing equipment and other apparatus. The interesting thing about these machines is that those with diametrically opposite products actually work on identical principles. Now, to work.

Energy—what is it? That's a tough question to answer in a few words. We live with energy every moment and can sense it when we move, or get hot, or get cold, or fall, and through other ways. Sensing it is not enough, we must be able to measure it and in this way perhaps define it.

Scientists usually define *energy as the ability to do mechanical work*. But in addition to this, Einstein postulated, some 50 years ago, that energy is also just another form of matter. This has been dramatically proven in the last 15 years with the creation of the nuclear-energy industry. His simple equation shows that one lb of matter equals 11.3 billion kwhr of energy. As interesting as this relationship is, we will not usually be concerned with it in the engineering thermodynamics that we'll talk about here.

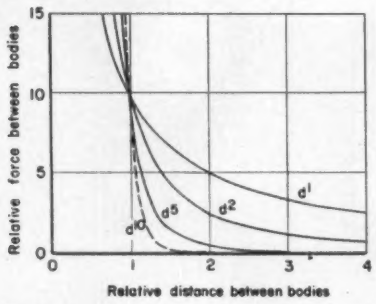
Mechanical work, since we hang our definition of energy on it, needs closer examination. We naturally think of work as the daily jobs we have to do. But mechanical work has a specialized meaning: *A force moving a body through a distance does mechanical work*. Note that the force must move to do mechanical work.

Look at it this way. When we push against a brick column, Fig. 2, we exert considerable force. But the brick column doesn't budge. So we're not doing any mechanical work because our force isn't moving. If we push a hand cart, we can move it. Now we're doing mechanical work. We calculate mechanical work as:

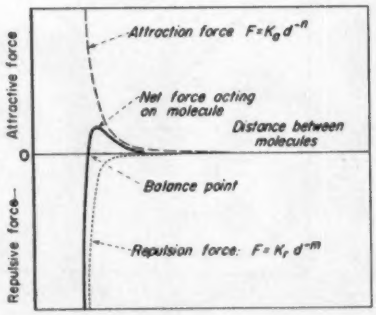
$W = F \times s$ where

W = mechanical work, ft-lb
F = force applied, lb
s = distance moved while force acts, ft

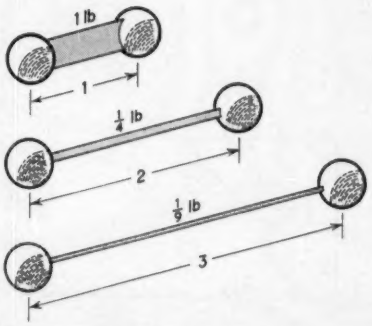
Example: By putting a spring scale between our hands and the cart handrail, Fig. 2, we find we are exerting a force of 15 lb while moving the cart a distance of 12 ft. How much mechanical work have we done? *Turn page*



10 Forces between bodies vary with the distance *d* between them, and on d^n



11 Net forces acting on molecules in a solid depend on sum of push and pull



12 Newton's law of gravitation shows the pulling force drops with distance

Internal energy has both kinetic and potential forms, the same as

Answer: $W = 15 \times 12 = 180$ ft-lb

Convertibility. Energy's ability to do mechanical work depends on proper handling. Basically, energy is a *condition* of a substance, but it usually does not affect the composition or weight of a substance except in chemical changes. Actually, the mass does change (Einstein's relation), but so slightly that we can ignore it for engineering work. For example, a body's condition changes when it gives up energy and this energy may do mechanical work on the body or some other body.

Energy can be changed into work, and work into energy. Since one can convert to the other, they are measured in the same units, ft-lb. Later on we'll find that work is really one way of transferring energy from one substance or body to another.

Energy forms fall into several types: mechanical, electrical, thermal, chemical, nuclear, light, radiation. Let's look at two mechanical forms that will be important to us: (1) potential and (2) kinetic.

Potential energy concerns the relative position of bodies. In Fig. 3, the weight M stood on the floor originally. By applying a force F on the rope we did work on the weight and raised it through s ft. For a frictionless pulley and weightless rope, $F = M$. Work done $= Ms$.

In the upper position the weight has potential energy with reference to the floor. Letting the weight fall allows it to do mechanical work equal to that done in raising it. Figure potential energy as:

$$E_p = Ms$$

The units are ft-lb. Graph of Fig. 3 shows the increase in potential energy with rise in height. Raising the weight half way to *a* gives the weight a potential energy of *ab*, which equals the work done. At full height, potential energy and work done equal *de*.

Kinetic energy concerns the relative movement of bodies. A body moving relative to the earth has kinetic energy. A bullet fired from a gun acquires kinetic energy, Fig. 6. This energy comes from the work that the expanding gases of the exploded powder do in pushing the bullet out of the gun barrel.

Once free of the barrel, the bullet travels at constant speed for a short time; its kinetic energy is figured as:

$$E_k = \frac{Mv^2}{2g} = \frac{Mv^2}{64.34}$$

E_k = kinetic energy, ft-lb
M = mass of moving body, lb
v = velocity of moving body, ft per sec

Example: At the instant a bullet leaves a rifle it has a speed of 1200 ft per sec. If the bullet has a weight of 2 oz, what is its kinetic energy?

Answer: $M = 2/16 = 0.125$ lb
$E_k = 0.125 \times 1200^2/64.34 = 2797$ ft-lb

By the time the bullet comes to a standstill it will do work equal to this amount. Before hitting the target, the bullet does much mechanical work in pushing aside the air (wind resistance); this takes away some of the bullet's kinetic energy and slows it down.

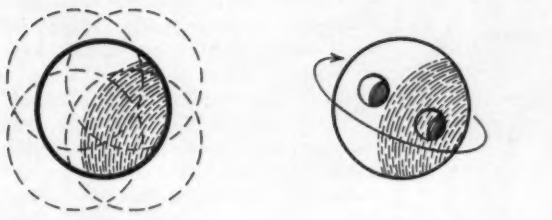
Changing energy form. Let's study the weight suspended in Fig. 4. Arrangement of weight and floor can be called a system; it has potential energy and for our purpose we may call it the total energy of the system. This is shown by the dash-dot line in graph at right, Fig. 4. The dashed line shows the potential energy of the system for different heights of the weight.

When we cut the rope holding the weight, what happens to the potential energy? It decreases in proportion to the loss in height. But energy can't just disappear. What happens to the lost potential energy? As soon as the weight is loose, it starts falling with increasing velocity as shown by the dotted curve. Increasing motion means the weight gains kinetic energy. There's the answer. Disappearing potential energy reappears as kinetic energy; the conversion is exact.

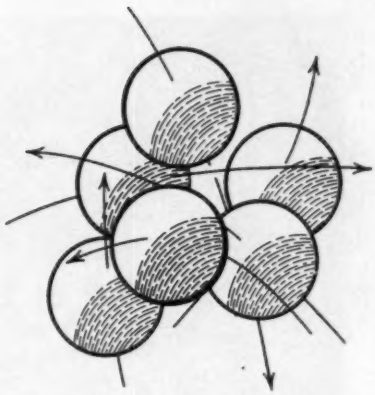
The solid straight-line curve shows the gain in kinetic energy with increasing fall and velocity gain. At any level the sum of the potential and kinetic energies equals the total energy: at *a* the potential energy has shrunk to value *ab*, kinetic energy has grown to *ac*, and their sum equals *ad*, total energy of the system.

Vertical time scale at the right of Fig. 4 shows the relative time taken for the weight to fall to the given height. If we're interested in changes in this system in terms of uniform intervals of time, we can replot Fig. 4, as shown in Fig. 5. This shows that the velocity increases uniformly with time, while the kinetic energy at first increases slowly and then with increasing rapidity as the velocity grows. The potential energy decreases in inverse fashion to the kinetic energy, as we would expect.

Internal energy. The instant the weight hits the floor it comes to a dead



13 Molecules absorb energy several ways. Three are by: (a) molecules vibrating in space (b) atoms rotating about each other (c) atoms vibrating inside molecule



14 Liquid molecules move close to each other at high speed in curved paths

large-scale mechanical forms of energy

stop. Potential energy has dropped to zero, kinetic energy has just reached the same value as total energy. But if the speed drops to zero, the kinetic energy must drop to zero too according to formula for E_k, since $v = 0$.

Where did the vanishing kinetic energy go? Touching the bottom of the weight and the floor at point of contact, we'll find they're both warmer than before impact. The kinetic energy has changed to *internal energy*, loosely called heat.

Here we see a whole series of energy transformations. Originally, work was supplied from somewhere to lift the weight above the floor. This transformed work to potential energy. During the fall, potential energy changed to kinetic energy; finally kinetic energy converted to internal energy.

Now we come to the prime consideration in our study. What is internal energy? How can we handle it? What can we do with it? These questions will be answered later as we study the various applications of converting internal energy to mechanical shaft power, creating lower temperatures, compressing gases, and so forth.

To get some idea of what internal energy is, we'll have to study the basic construction of matter. Matter may have three different *phases*, as scientists call them: (1) solid (2) liquid (3) gaseous.

Solids. Let us take a solid, a piece of metal, say, and start cutting it up. We'll take a small piece and cut it in half; take one of the halves and cut that in half; take one of the quarters and cut that in half; and so on and on. Pretty soon we'll find ourselves working with a microscope, halving the piece of metal dust remaining. Eventually we'll find that a microscope can't help us see the remaining particle. But all along we'll notice that the nature of the metal hasn't changed, the pieces of all sizes are alike.

To get down to submicroscopic size we have to use imagination. On the basis of their experiments, scientists have drawn imaginary pictures to help explain the behavior of matter. These pictures aren't perfect in that they reveal everything, but they go a long way in explaining actions that otherwise appear mysterious.

Atoms. Our speck of invisible metal dust might be made up of little round balls arranged in regular rows and layers, Fig. 7. Each little ball is an atom of metal, the smallest package that we would still recognize as a piece of the metal we started cutting up. This is true if the metal we deal with is an element, like iron, tin or silver.

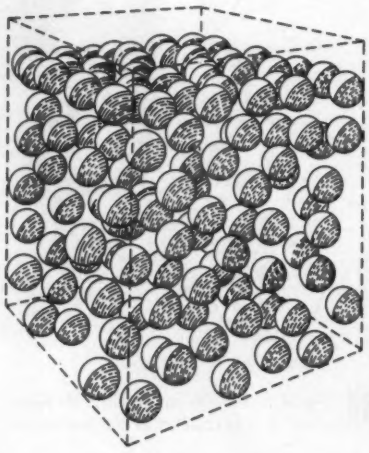
Looking closer, we find this little ball a rather fuzzy thing, the apparent surface being made up of "clouds" of electrons circling around a tiny nucleus at very high speed. The incredibly tiny nucleus, in turn, is made up of particles called neutrons and protons. The positive electrical charge carried by the protons holds the negatively charged electrons in their orbits while circling the nucleus. For the purpose of thermodynamics we need be interested only in the atom as a whole. We regard it as an equivalent solid ball, unbreakable, and always acting as a single body.

Believe it or not, these little atoms, Fig. 7, stand in space, some distance from each other. This means that all solids include a lot of completely empty space. This is rather hard to believe on first thought, but if this space isn't there, some ways that solids behave would be impossible to explain. If the matter we study should be made up of several elements, the atoms would be arranged in regular patterns making up molecules which look like larger balls.

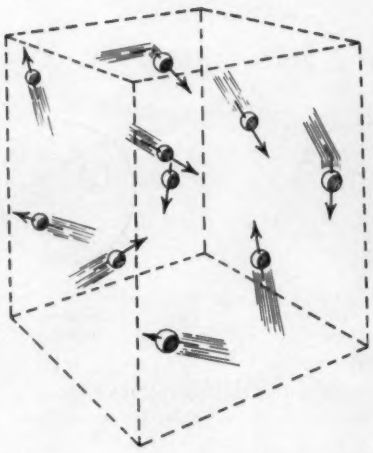
Forces. How can atoms stand in empty space without visible support? They do so because atoms exert forces of attraction and repulsion on each other. These forces are similar to gravitational and electrostatic forces. Let's break off a small cube of matter, Fig. 8, with dimensions of three atoms along each edge. This cube has one central atom. Fig. 9 shows the lines along which this atom interacts with each of its 26 neighbors.

The *molecular forces of attraction* are like the gravitational forces of attraction described by Newton's famous law of gravitation: $F = M_1M_2/d^2$. Gravitational forces are proportional to the masses of the two bodies involved and inversely proportional to the square of the distance d separating them. In solids, atoms behave similarly except that the exponent for d varies from about 5 to 6 instead of being 2 as for gravitation. *Forces of repulsion* between atoms might be caused by the electrical repulsion between the negative charges of their electrons. Repulsion forces vary inversely as the 9th to 14th power of d. Fig. 10 shows the effect of these exponents on the magnitude of the forces.

Fig. 11 shows the net effect of the two



15 Liquid molecules occupy bottom of container, form nearly level surface



16 Vapor molecules zoom through space in straight lines, and collide often

types of forces in maintaining distance between atoms. At one given distance these forces are in balance and the net force acting on a molecule is zero. If the distance between atoms is reduced the net force of repulsion builds up rapidly. On the other hand, increasing the distance between molecules causes the net force of attraction to increase for a short range and then fall off. When the distance has been doubled, the net force of attraction is very weak and practically disappears for greater distances.

Fig. 12 gives a more concrete picture regarding forces of attraction between bodies obeying Newton's law of gravitation. If the attraction is 1 lb at distance 1 (shown by width of connecting bar) the force will be only ¼ lb at a distance of 2, and only 1/9 lb at distance 3. For atoms with the force varying with $1/d^5$, doubling the distance reduces the force to 0.03 lb, while tripling the distance reduces the force to a mere 0.004 lb, entirely negligible. This variation will be important to us later in understanding change of phase during boiling and condensation.

Motion. As we look at Fig. 7 and 8, the atoms appear very calm. They would look this way only if they had no internal energy, that is, their temperature would be at absolute zero. At room temperature the atoms are buzzing with action. Each individual atom bounces around rapidly, but stays in one general location in the solid tied by molecular forces. The hotter the solid, the more active the atoms become, Fig 13 *a*; this shows as a temperature rise.

In the more general case where a solid is made of molecules, the molecules may consist of two or more atoms each. Molecules as separate units may then be represented by the single balls in Fig. 7, 8 and 9. Molecules may absorb energy in more than the kinetic vibration form of Fig. 13*a*. Within the molecule the atoms may revolve about the center of the molecule, Fig. 13*b*. The higher the rotation speed, the more energy the molecule has. The atoms may also vibrate in respect to each other within the molecule, Fig. 13*c*. These last two forms of energy may have no effect on the measured temperature, though they may vary with it.

All these forms of motion show the ways in which a solid may absorb or give up energy. At a given temperature level, individual molecules in a solid have varying amounts of energy. But considering all the molecules of a mass as a group, their internal energies (in all three forms) add up to a fixed amount per unit of weight for each temperature level.

Liquids. When heating a solid we find it melts at a certain temperature. Certain solids, like ice, change from solid to liquid with addition of heat, but the temperature stays constant during this heating. How do we explain this with our molecular picture?

As the molecules absorb more energy in the solid phase, they bounce through greater and greater ranges, with increasing speed and frequency. The increasing motion makes the solid expand. At a certain temperature level some molecules bounce around so hard they break away from the attractive forces of their neighbors and begin to wander off between the other molecules. They follow a curved, winding path under the pull of the forces from the molecules they pass. But their energy (speed) is high enough so they can break away each time, Fig. 14.

Heating the solid does mechanical work on the individual molecules and increases their motions. It takes additional work to break the molecules away from the restraining forces holding them in place. Molecules absorb this type of work as internal potential energy. In the melting process molecules successively break away from the ordered pattern in the solid phase, Fig. 7, until they are all wandering about each other in curved paths, Fig. 1 and 15. They fill the bottom of any container holding them, have a level top surface, and are closer together at the top.

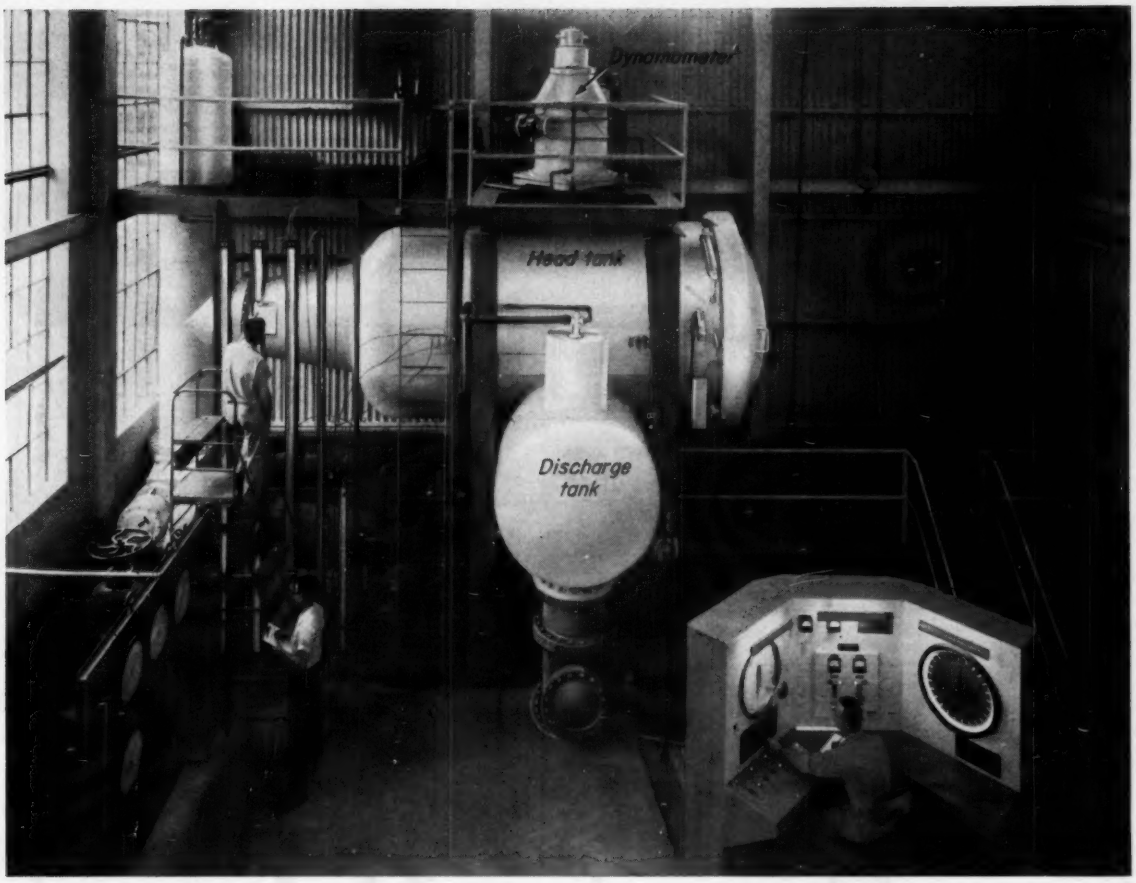
Heat absorbed as internal potential energy does not affect the ***average*** speeds of the molecules, so the temperature does not change during melting. Temperature indicates internal kinetic energy of the molecules, that is, translational motion only.

Vapors and gases. Continued heating of a liquid raises its temperature, meaning the speed of the molecules. Again, individual molecules have different velocities, but the average speed of all the molecules corresponds to a definite temperature level.

When the liquid reaches boiling temperature, the molecules with higher speeds (energy) break away completely from their neighbors and zoom up into the space above the liquid. These molecules do additional work in breaking away from the force of their neighbors, which they absorb as potential energy and which slows them down to the average speed (temperature) of the liquid molecules. This work they have absorbed as internal potential energy.

So we find that temperature of a boiling liquid stays constant until all the liquid changes to vapor. Once all the liquid has evaporated, the molecules soar through space at high speeds, in practically straight-line paths, Fig. 16. They travel at speeds of 15 to 70 miles *per minute* at ordinary room temperatures. The molecules collide with each other and the container walls billions of times in one second. Speeds increase with heating and, of course, the temperature goes up. The vapor or gas (the difference is arbitary) occupies much more space than the liquid for the same weight or number of molecules.

Next installment will review the meaning of energy and pressure and study gas laws—in a forthcoming issue.



WHEEL CASING, in which turbine runner models are tested, is mounted in a 7-ft-head tank pressurized by two 300-hp 9500-gpm pumps in this hydraulic laboratory. A 300-hp, 0- to 6000-rpm, eddy-current dynamometer measures turbine output

Hydro test stand develops 300-ft head

► On June 14, 1956, a group of technical-press editors attended a preview of a new high-head hydraulic-turbine test stand in the S Morgan Smith laboratory at its main plant, York, Pa. This laboratory now has five stands for testing models of hydro turbines, pumps, pump-turbines and other hydraulic equipment.

1. A low-head open-flume test stand is used for basic research and running formal acceptance tests on francis, kaplan and propeller turbines. Models with a 16-in. discharge are tested under a 10-ft head.

2. A pressurized system was built in 1941, as the company's first cavitation laboratory, to test models of the high-head (105-ft) kaplan-turbine project on the Negro River in Uruguay. Test heads up to 50 ft are available and 12-in. models with complete spiral cases and draft tubes can be tested in this stand.

3. A horizontal-shaft impulse stand is used primarily for basic research on impulse-turbine runners and nozzles. Bucket and splitter designs, number of buckets, wheel housing proportions, also size and shape of jets are investigated.

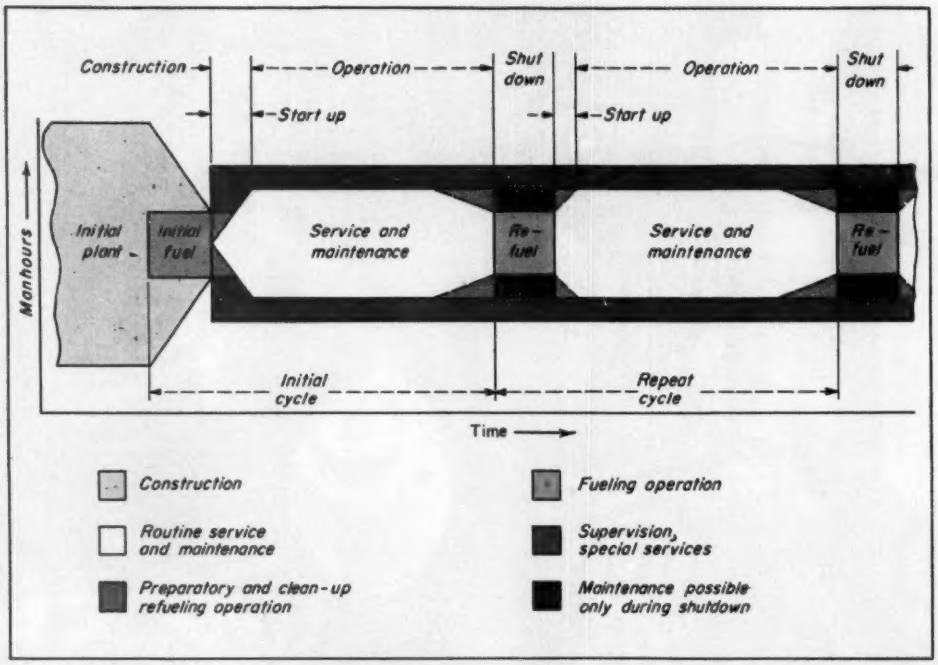
4. Designed originally for testing fixed- and adjustable-blade axial-flow pumps, the pump-turbine stand can now test mixed-flow centrifugal pumps and pump-turbines. Models with eye diameter up to 12 in. can be tested under heads up to 85 ft.

5. The company recognized the necessity of reliable numerical results to successfully develop turbine runners that meet the needs of higher speeds, smaller diameters and reasonable settings for any head. Accordingly, in 1952 they decided to build the high-head test stand, shown in the photo, that can provide a 300-ft head.

The wheel casing, in which the model of a turbine runner is tested, is mounted in a 7-ft-diameter head tank. An elbow draft tube for the test runner discharges through the bottom of this tank into a 5-ft-diameter discharge tank. A 300-hp, 0- to 6000-rpm, eddy-current dynamometer measures turbine output.

Suspended from the dynamometer frame the wheel case, including the wicket gates and operating mechanism, stay ring, bottom ring and head cover, is supported independently of the head tank and other parts of the pressurized

(*Continued on page* 194)



1 Man-hours devoted to various services and operations depend on cycle of nuclear-fuel charges. Work on primary loop and reactor concentrates at the time reactor is out of service for refueling

Skillfully planned operating programs keep

First of a 3-part article details auxiliary systems serving a reactor, outlines major aspects of refueling operations, lays down the important aims of industrial hygiene control

► To SAY THAT the principal difference between conventional and nuclear power plants lies in the heat source is an oversimplification: They differ in other important respects too. Steam power plants of any kind, however, do have certain things in common.

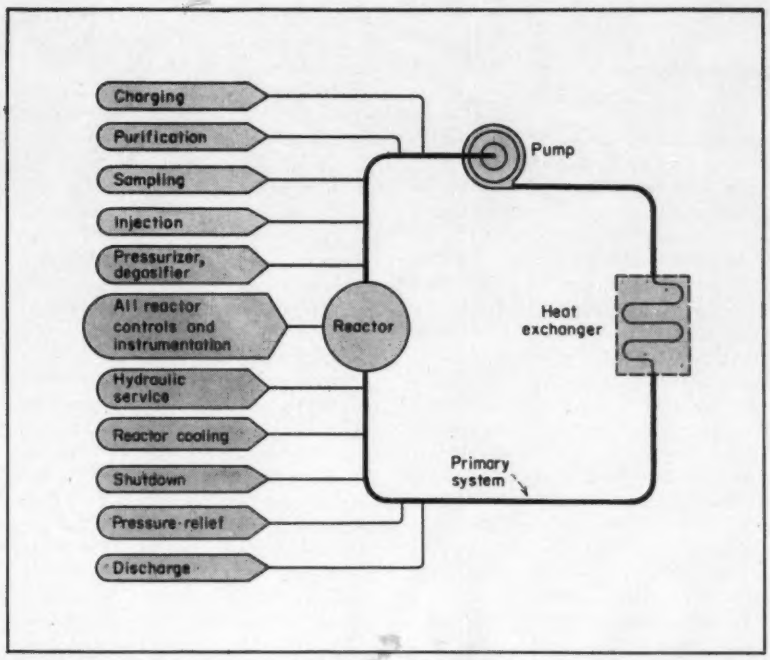
Progress. Many modern steam plants run automatically, needing a minimum of attention. But nuclear plants, starting with a large number of unknowns a few years ago, had to be built with extreme precautions in their design. Experience has shown that many of the precautions can now be relaxed. But techniques in handling some operations have become very specialized. The reason is SAFETY.

In addition to hazards of high temperature and pressure the nuclear plant has an unseen one, RADIATION. Sealed systems must contain the heat-transfer medium, and shielding must protect personnel from dangerous exposure. Radiation complicates the entire service and maintenance program. An extensive industrial hygiene program must protect against radiation and contamination hazards. Specially trained personnel have to be used to assure safe plant operation.

Personnel. Economic necessity dictates employing as few operators as possible in any power plant. To aid this aim, the designer keeps in mind both *serviceability* and *maintainability*. Both designer and contractor must understand the importance of these early in the program. Without them an inefficient service and maintenance program results, or expensive alterations are needed in the near future.

Generally a nuclear power plant may be run with a fixed size crew for service and maintenance once operation starts, Fig. 1. With construction completed, plant personnel handle all normal functions. The initial cycle starts with the first fueling and ends with the first refueling shutdown. The repeating, second cycle then starts after the first refueling with resumption of energy output. Fig. 1 assumes that all training of personnel was completed during construction.

To minimize shutdown time, preparation must be thorough. Well before anticipated shutdown, key personnel break away from routine duties to make preparations. Major items of primary plant maintenance must also be done during shutdown for refueling. Little maintenance can be done during plant



2 Primary-system loop centering on reactor core must be served by eleven different auxiliary systems for safe operation and maintenance while carrying the load

nuclear power plants on line: 1

By R E CREWS and J M YADON
Westinghouse Electric Corporation

operation because radiation hazards make the primary system almost completely inaccessible.

Contrasting with conventional plants, the nuclear plant must be shut down for refueling. This can only be done by opening and recharging the fuel container. Recharging can be dangerous and special precautions are taken. We'll say more about this later.

After shutdown all personnel may return to routine duties except those handling tasks supplementary to refueling. Fig. 1 shows supervision and special services enveloping the entire service and maintenance program. Reactor systems with multiple loops and standby facilities can be arranged to reduce shutdown time to a minimum.

Because of rapid advances in technology, many methods we'll talk about here may soon become obsolete, but fundamental ideas should not change much in the near future. Though we'll talk about watercooled water-moderated reactors, much of our discussion also applies to other types of reactor plants.

SERVICING FACILITIES

Nuclear-power-plant servicing will include many operations used daily in conventional plants. Keeping in mind the demand for cleanliness and personnel safety in nuclear power plants let's look at the special servicing facilities needed, Fig. 2.

Charging system supplies makeup water for the primary system of the reactor and water for filling, purging and backflushing as needed. Water purity must be well above present commercial standards. An auxiliary water purification system treats the water. Instrumentation measures the temperature, pressure, flow and purity of the charging water. Chief operator directs manual operation of the charging system.

Purification system removes dissolved and suspended impurities from the primary coolant. Normally a bypass system, it operates continuously when the plant runs. Before startup and after shutdown it may run intermittently. Strainers, filters, demineralizers and piping comprise the system.

This system serves as extra insurance that the primary coolant remains free of foreign elements. Operating the system involves (1) sampling water to check cleaning effectiveness (2) flushing filters and strainers (3) replacing demineralizer resin periodically.

The system runs automatically after manually setting the flow rates. Pressure drop across filters and strainers shows need for back-flushing. The chief operator directs this manual operation.

Sampling system made up of piping, valves and collecting vessels draws off primary coolant samples to check its conductivity, pH, concentration of dissolved gases, concentration of suspended and dissolved solids, and radioactivity. Sample analyses help to (1) determine additives to be injected into system, or (2) correct operating procedure. The system, manually operated, helps to check the primary system chemistry periodically.

Injection system consisting of piping, valves and storage tanks adds inhibitors to the primary coolant system. The system, manually operated, helps control primary-system chemistry.

Pressurizer and degasifier system controls pressure of the primary system and bleeds off unwanted free gases. Intermittent heating of the water or spray cooling of the vapor in the pressurizer vessel regulates the primary coolant pressure. The vessel also acts as the surge tank for the system. Vent connections bleed off the free gases released by corroding action and irradiation of the primary water.

Instrumentation and controls allow automatic or manual pressure regulation after start up. Plant operators usually control degasification operations manually.

Reactor controls and instrumentation help match reactor power output to demand on the plant. Three principal parts make up the reactor plant: (1)

Reactors need special auxiliary systems

pressure vessel and reactor core (2) piping loop through which the coolant flows (3) steam generator. Negative temperature characteristic of the water-cooled water-moderated reactor aids control stability. Positioning control rods in the reactor core controls the power output.

Automatic control regulates the rods within the operating power range. Remote manual control usually regulates during startup and shutdown operations. The system scrams the reactor when trouble arises.

Instruments measuring flow and temperature in the secondary steam system feed control signals back to the primary controls. The controls regulate the power output and keep the primary coolant temperature within narrow limits. Using differential pressure cells, servomechanisms, resistance thermometers, magnetic- and vacuum-tube amplifiers and other precision instruments assures accuracy and reliability of control and allows isolating the control stations from the reactor.

Reliable and sensitive nuclear instruments measure conditions within a reactor. These include fission counters, compensated ion chambers and BF-3 (boron trifluoride) proportional counters. Amplifiers adapt these instruments to conventional switches and relays used at control stations. Mounting this equipment on chassis makes it possible to remove the control components as a group for easy service and maintenance procedures.

Primary-plant-control system regulates the pumps, valves, heaters and auxiliary systems that handle the primary coolant. This control system supplements the reactor control system. Instruments show coolant flow, temperatures, pressures; positions of control rods and primary valves, pump status, etc. Alarms alert operators to abnormal conditions.

Hydraulic service system boosts remote operation of large components, such as cylinder-operated valves. The system has a pumping station and distribution piping to pilot and main valves and may supply pressure head for the purification system. This system uses pure water to avoid contaminating the coolant. The system runs automatically after manual starting.

Reactor cooling system dissipates the heat generated in the reactor immediately after it is shut down. As the plant cools, additional makeup water maintains system pressure. High-pressure storage flasks act as an auxiliary system to supply this additional pure water. These systems may operate independently or simultaneously. Both act as reactor safety features.

Shutdown systems include the control system, which may be used to shut down a reactor manually in normal fashion or automatically under emergency conditions. A chemical shutdown system may be provided as a back-up when normal controls become inoperative or reactor control rods stick. This system has a chemical storage tank, pumps and piping to inject chemical poisons into the primary coolant system. They halt the chain reaction and shut down the reactor. This system would be manually operated and strictly on a back-up basis.

Pressure-relief system operates whenever pressures rise too high from overcharging, thermal expansion, or a severe transient. This safety system uses pressure-activated relief valves. The chief operator normally controls the system pressure for usual conditions.

Discharge system handles water taken from the primary system. It also bleeds off water during heat up, drains the loop, drains a component, and handles effluent from a servicing operation such as back-flushing of filters and strainers. The system also acts as a disposal facility for radioactively contaminated resin from the demineralizer. The system is controlled manually.

In addition to these 11 systems there are other minor systems, including: temperature monitoring, radiation monitoring, high-pressure air, air conditioning, fresh-water cooling, makeup-water purification. The latter tend to be conventional in design.

REFUELING OPERATION

Taking the depleted fuel out of the reactor vessel during refueling raises the greatest hazard to personnel. Radioactivity and heating drop quickly upon reactor shutdown, but remain high enough to be dangerous if the fuel is not handled with proper caution.

The refueling operation uses special techniques and equipment, such as underwater handling and heavily shielded containers. Effective shielding, monitoring equipment, protective clothing and decontamination facilities must be used. The refueling crew consists of a minimum number of men to reduce the exposure in an accident. Despite the extremely remote possibility of an accident the plant is usually cleared of all persons except those needed during refueling.

Refueling needs a good deal of preparation. Practice dry runs are usually made using the handling equipment. All lifting gear, chains, cables, hoists are thoroughly inspected and tested. Additional auxiliary shielding like temporary barriers or water-flooded transfer canals or both are needed. Shielded storage space, usually underground, permits isolating the depleted fuel assembly while giving maximum access to the primary system.

Before opening the pressure vessel, the filters and demineralizers remove radioactive corrosion products and other foreign matter from the coolant. The worst situation occurs when a fuel element ruptures and releases fission products into the coolant. Then filtration and demineralization have to be continued for an extended period. Sometimes chemicals may be used to aid in flushing out the contaminants.

The industrial hygiene group gives invaluable assistance during shutdown by monitoring radiation levels, assisting in decontaminating equipment, adminstering an overall safety program.

After removing the depleted assembly and before installing the new core, a large reactor vessel filter removes any foreign residual contamination from the coolant. Installing the new core is comparatively simple since it is not dangerously radioactive except for its relatively small startup source.

During the refueling shutdown with the primary system depressurized and open, the primary-plant repair, maintenance and replacement of parts can be done most effectively. We'll talk more about maintenance practices later.

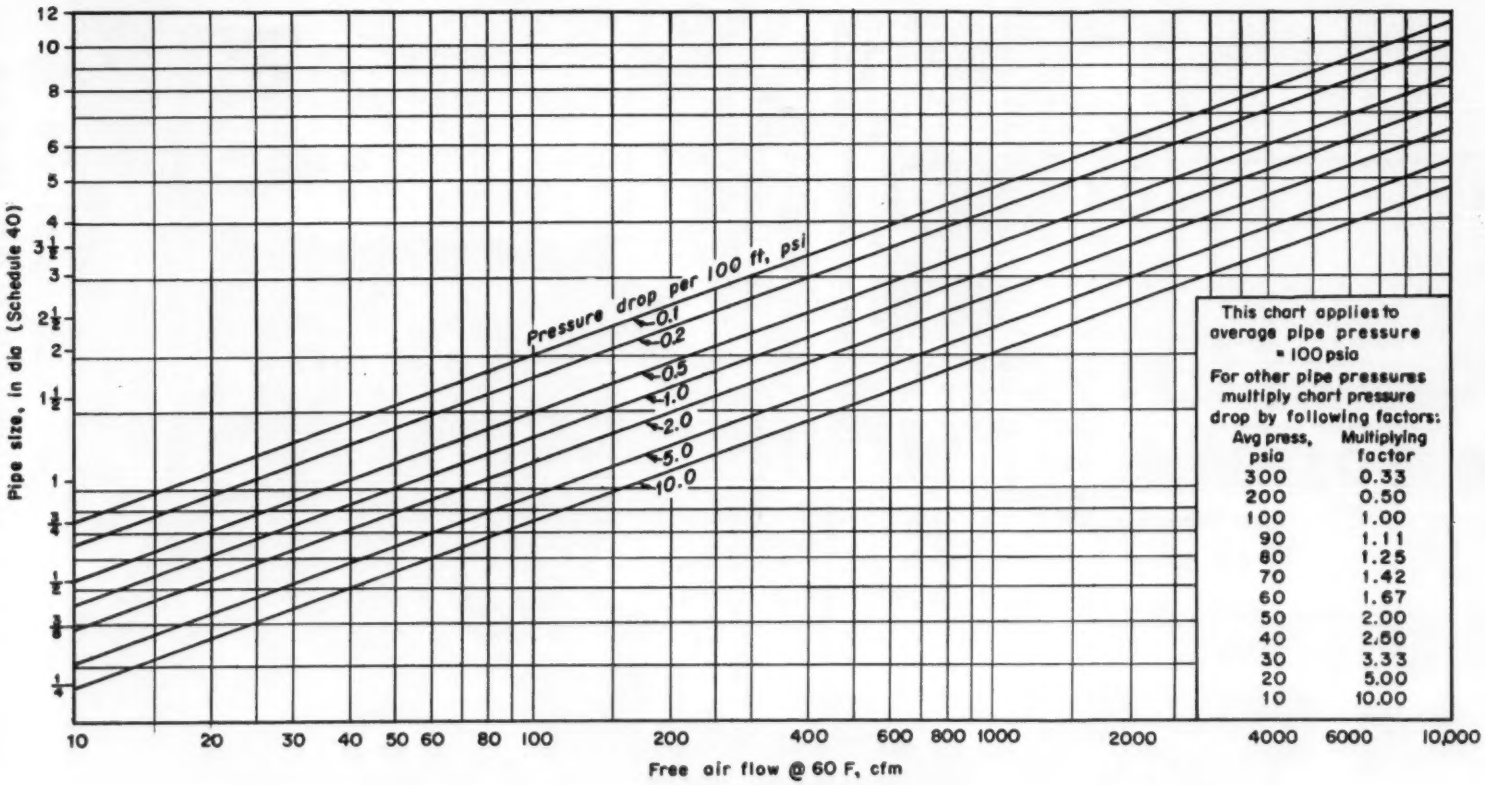
INDUSTRIAL HYGIENE SERVICES

A hygiene program aims to prevent plant personnel receiving overdosage of radiation. This program cannot be overstressed or appreciably simplified. Maximum allowable human dosage of 300 milliroentgens per week has become a widely accepted standard.

Contamination from minute radioactive particles can be dangerous. It takes a number of forms including: surface, fluid, air-borne and solid. Various methods can remove the harmful effects: time itself can help because radioactivity decays with time; some radioactive isotopes, however, have extremely long half-lives and must be removed. Surface-wiping and rinsing affected parts are effective. Sometimes chemicals help break loose particles bearing radioactive materials.

Excellent equipment is available for

(*Continued on page* 188)



Choosing pipe sizes for compressed-air systems

► KNOWING THE CFM of free air you want to transport, the average air pressure in the piping system and the pressure drop you can allow, this chart helps you select quickly the proper size pipe, schedule 40.

The chart applies directly to 100-psia average air pressure, but simple multiplying factors in the table can correct it to any other average pressure you may want. The chart is based on the Harris formula:

$$p_1 - p_2 = \frac{LQ^2}{2390 \left(\frac{p_1 + p_2}{2}\right) d^{5.31}}$$

p_1 = air pressure at piping-system inlet, psia

p_2 = air pressure at piping-system outlet, psia

L = equivalent length of pipe, ft

Q = free air flow at 60 F. cfm

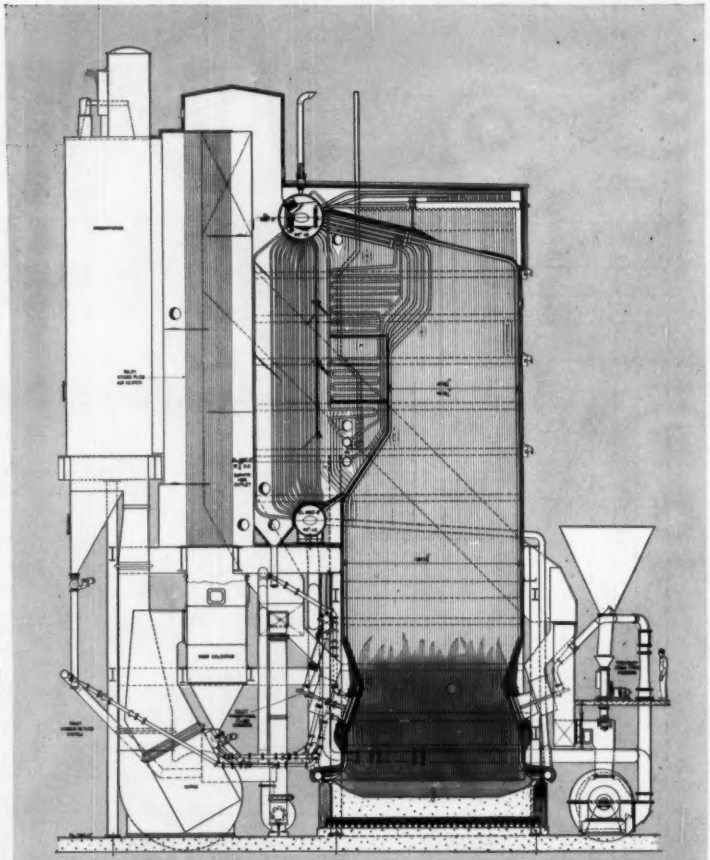
d = pipe actual inside diameter, in.

At other than 100-psia average pressure, multiply pressure drop $p_1 - p_2$ by factor corresponding to pressure in table.

WILLARD M ELLER *Kekaha, Hawaii*

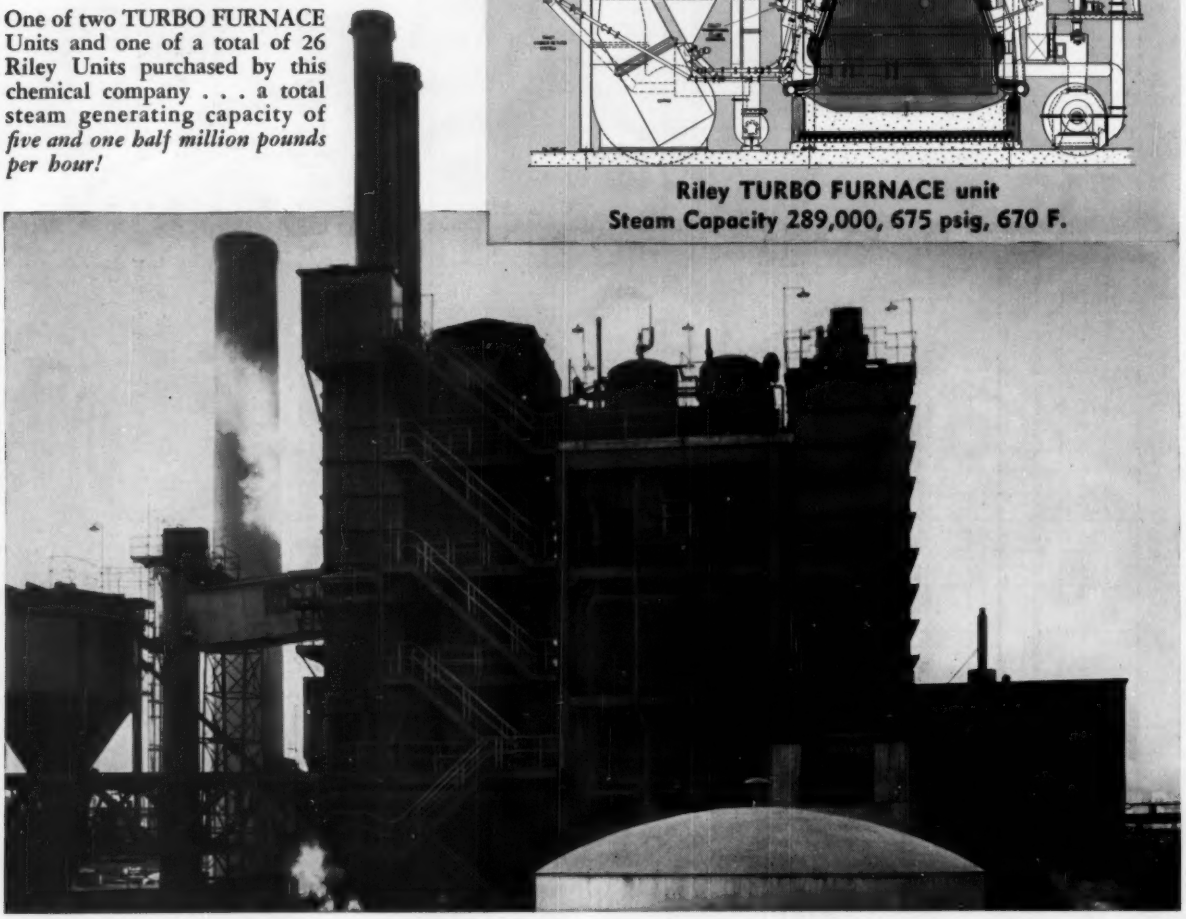
A 1955 POWER MODERNIZATION AWARD WINNER

This 289,000 lb./hr. Riley TURBO FURNACE Unit replaces several low capacity, low efficiency units and is part of a modernization program that has resulted in a total of $470,000 annual savings on the making of steam by the original boilers. A considerable part of this saving is due to the TURBO FURNACE Unit's high efficiency, low carbon loss in fuel, lower maintenance, elimination of flyash disposal problem.



Riley TURBO FURNACE unit
Steam Capacity 289,000, 675 psig, 670 F.

One of two TURBO FURNACE Units and one of a total of 26 Riley Units purchased by this chemical company . . . a total steam generating capacity of *five and one half million pounds per hour!*



A survey of your plant by a consulting engineer could show you ways of making surprising savings in your power costs.

TURNS FLYASH INTO PROFITS

for prominent West Virginia Chemical Company

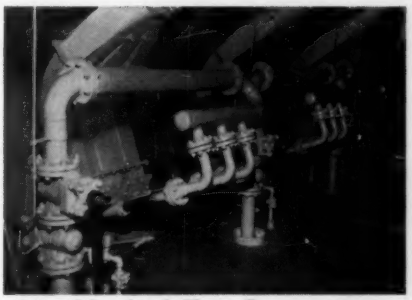
The *New* RILEY

TURBO FURNACE

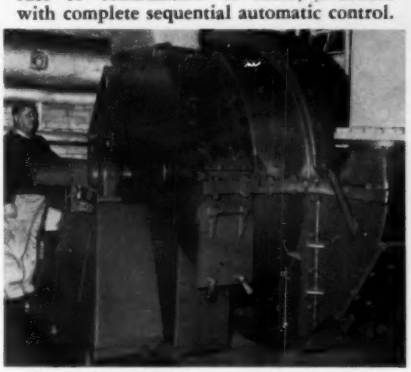
Once flyash disposal was a major problem for this company. Today Riley TURBO FURNACE Units are helping to solve this problem. At Plant (A) flyash is reinjected into the TURBO FURNACE combustion zone where high heat concentration and extreme turbulence converts ash to slag; when tapped and cooled, slag is easily disposed of, resulting in a usable product and a substantial savings in net cost of plant operation. At Plant (B) another Riley TURBO FURNACE unit successfully burns its own flyash . . . and even flyash from an adjacent dry bottom unit.

. . . in addition to eliminating flyash disposal, the Riley TURBO FURNACE also offers users these advantages:

- **Will burn efficiently a wide range of coals, oil, gas, lignite, delayed coke, and fluid coke.**
- **Low carbon loss increases unit efficiencies, lowers fuel cost.**
- **Clean heating surfaces do away with slag blowers.**
- **No stratification of furnace gases.**
- **Furnace exit gas temperatures are the same regardless of fuel.**
- **No change in pressure parts needed when converting to solid fuels.**
- **One level burner operation.**
- **Higher heat release rates: lower overall height.**



Riley Directional Flame Burners use any fuel or combination of fuels; available with complete sequential automatic control.



Riley 550 Pulverizers with Tungsten Carbide faced grinding elements resist wear and reduce maintenance.

UNITS WITH RILEY TURBO FURNACES ARE DESIGNED FOR ANY CAPACITY, PRESSURE, TEMPERATURE

TURBO FURNACE Units have been purchased by *Delaware Power & Light Co.* — three 500,000 lbs./hr. units designed for firing fluid coke; *Texas Electrice Service Co.* — 825,000 lbs./hr. reheat unit designed for firing gas, oil and Texas lignite; *Louisiana Power & Light Co.* — one 1,550,000 lbs./hr. reheat unit designed for firing gas, oil, coal and fluid coke; *Kaiser Aluminum & Chemical Corp.* — two 320,000 lbs./hr. units for gas and oil, future coal.

Consult your Riley Representative in these cities for complete details about the Riley TURBO FURNACE.

Worcester, New York, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Houston, Denver (Englewood), Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

RILEY

Stoker Corporation

WORCESTER, MASSACHUSETTS

. . . there's enough difference to make ALL the difference

This is just one inspection of extrusion dies through which a cast billet heated to a rigidly controlled temperature is hot extruded into a "tube shell" . . . from which Scovill Heat Exchanger Tube is subsequently cold-drawn.

One of the most highly skilled and critical jobs in the process is that of finishing and maintaining these dies. The smooth, clean surfaces of resulting shells are essential assurance of highest quality in finished tubes.

It is needless to tell Scovill customers that, while *correct alloy selection* is important to efficient exchanger operation, of equal importance is the *uniformity and soundness of tubes* themselves. Scovill Technical Service and tube production methods, considered by many the very best in the industry, can give you complete assurance on both these essential counts.

Scovill Heat Exchanger Tube is available in a comprehensive range of standard alloys (listed below).

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

SCOVILL

HEAT EXCHANGER TUBE

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

1sc56

STEVE ELONKA
Associate Editor in Charge

Going over these employe records helps . . .

Step up performance

By **ARTHUR E ORIEL**, *Science Research Associates*

Six dividends from records . . .

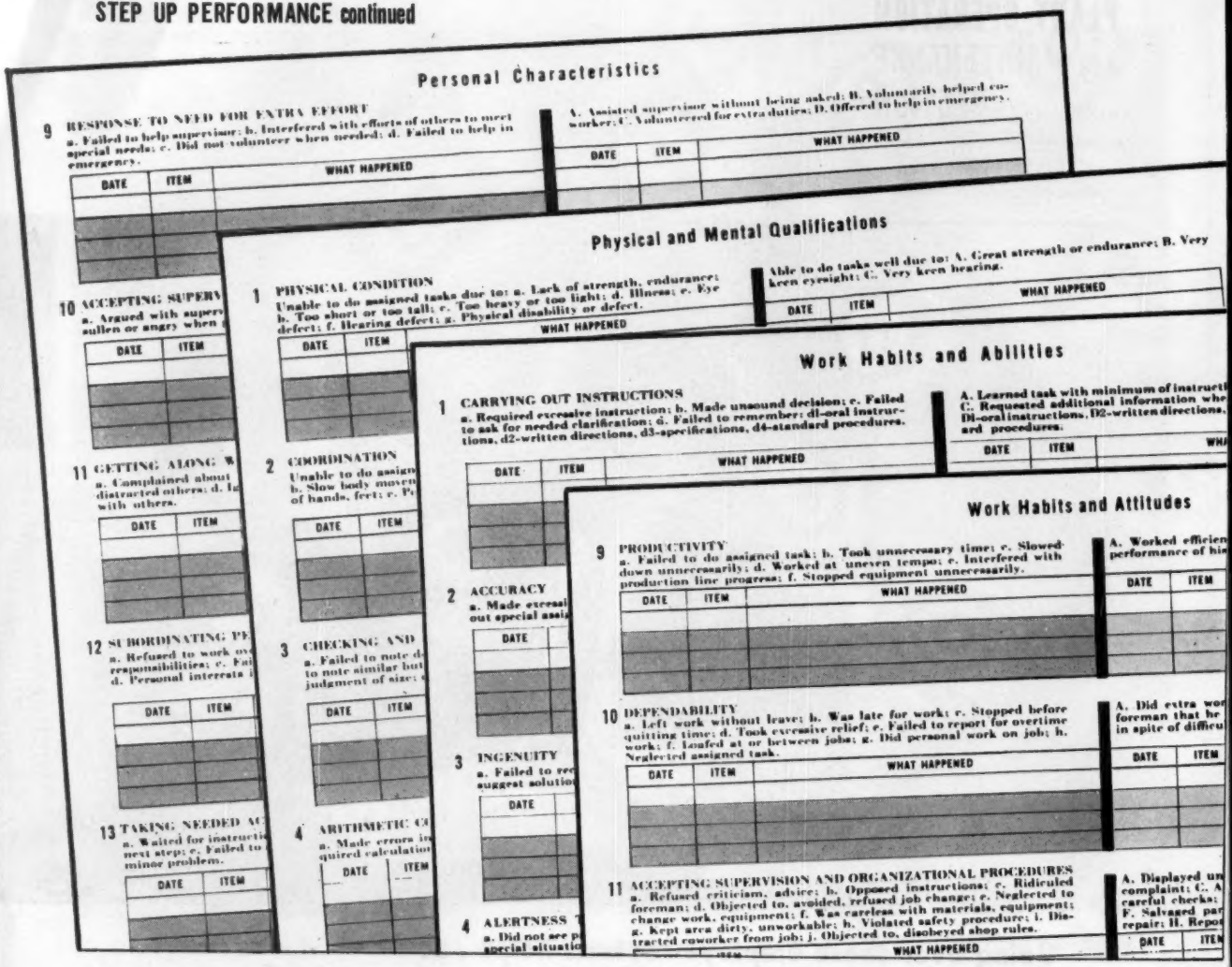
1. **Develops full employe potential**
2. **Determines merit raises**
3. **Supports disciplinary action**
4. **Identifies promotable people**
5. **Suggests transfers**
6. **Specifies the kind of help needed**

► PERFORMANCE IS WHAT COUNTS whether you're talking about men or equipment. But it's much easier to keep machinery at top efficiency than maintenance and operating men. This truism used to be in the class with the weather —lots of talk but no action. But lately some new ideas are paying off. Terms like *performance evaluation* and *employe development* can now be taken out of personnel textbooks and put on the shop floor where they belong. Result: personnel efficiency.

Critical-incident method. Once you hire an employe, how do you get the best work from him? The critical-incident method offers one way to pick up where effective selection leaves off. It was first applied to performance appraisal during World War II by Dr John C Flanagan, who is now Professor of Psychology at University of Pittsburgh.

After the war, Dr Flanagan applied his psychological know-how and his wartime experience to industry's personnel needs. Results: (1) Battery of aptitude tests based on critical requirements of various jobs. (2) Use of critical-incident technique to evaluate industrial situations.

(Turn page)



Performance sheets are made up to classify all the important characteristics of your employes that affect their success

What is this new method? Program's evaluation procedure is somewhat similar to that of methods men. Original researchers, using foremen as observers, studied what employes do on the job. But instead of looking at operational details, they watched everything—relations with other employes, quick thinking, judgment, responsibility, leadership, utilizing strength and skill, inventiveness, capacity to learn, and many other seeming intangibles that contribute to an employe's success, failure or mediocrity.

After thousands of critical-incident observations were tallied, a definite pattern emerged. Psychologists saw they had a framework of key aspects for individual employe performance—aspects that work for or against overall personnel efficiency. Researchers knew behavior traits they found couldn't be measured with a stop watch. So they didn't set rigid standards. Instead, the crucial, effective-ineffective performance elements were classified under 16 headings and printed on forms called Performance Records or Incident Sheets.

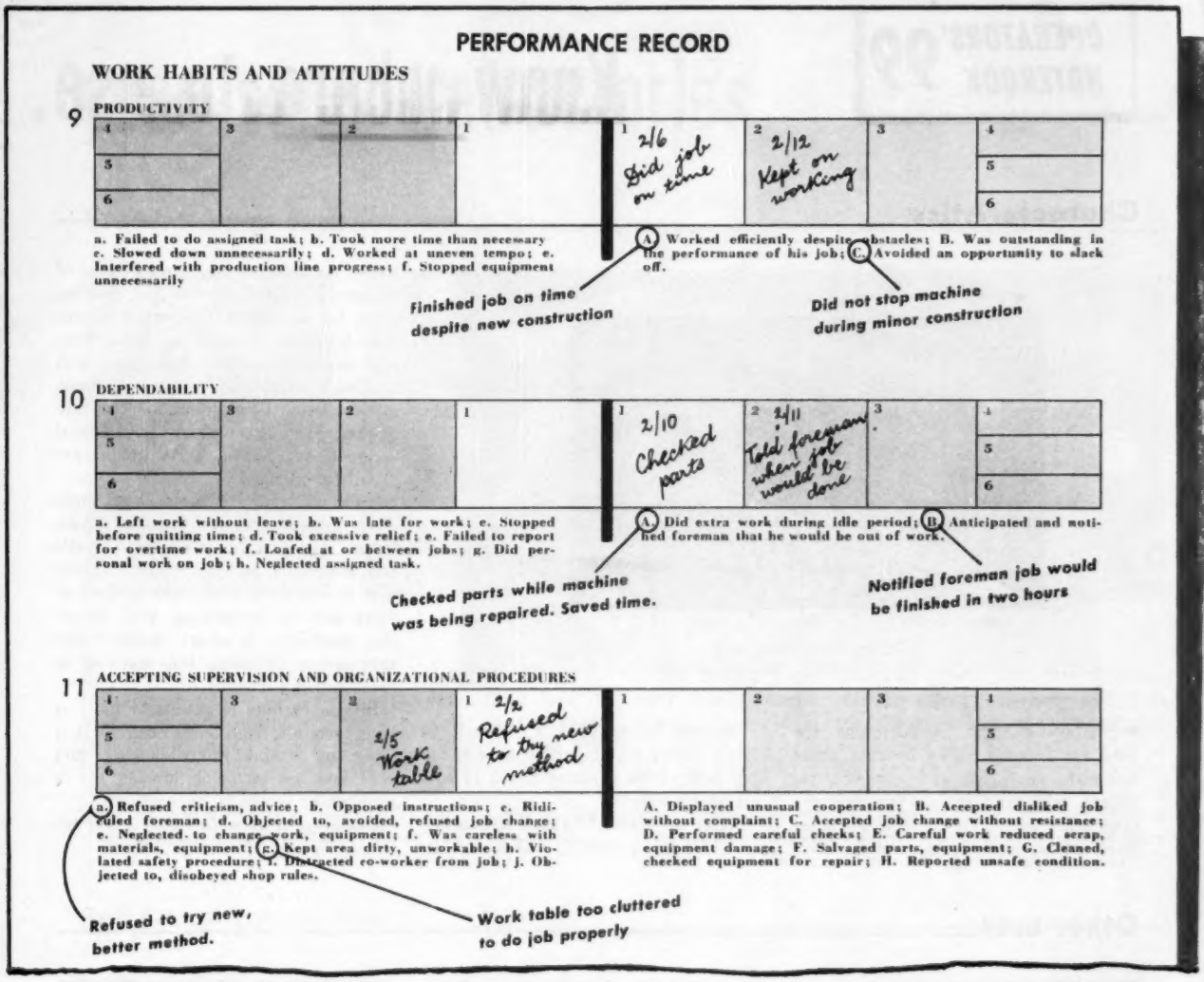
These recording forms (paper work part of program) are designed so supervisors can jot down notes on each employe's critical incidents as they occur. Supervisors can identify and classify genuinely critical incidents in a short time. Before long the recording process becomes second nature to them.

Important part of program is what's done with record-keeping results. During several months a wealth of information is accumulated on employe records. Then these records are ready for interpretation and employe development. This is the next step toward long-range ever-present goal of maintaining a high level of personnel efficiency.

Employe development in action. Does the performance-record program work? Reports from users indicate it does. One plant foreman said: "In every case where I sat down and talked to an employe about his record, his work improved—maybe only a little, but he did a better job than before." He referred to performance-review phase of program. Here employe and supervisor sit down together and interpret the recorded critical incidents. This employe-participation aspect is the secret of the program's success.

Conference idea improves communications, but thinking out loud does more than that: It encourages the supervisor to analyze the critical-job requirements of individual employes. It encourages the employe to think constructively about himself and his growth potential with the firm that hires and trains him. Here are examples of employe development from using this Performance Record. These are from maintenance-supervisor reports of a large corporation:

1. Increased productivity. "I have an employe who kept


PERFORMANCE RECORD
WORK HABITS AND ATTITUDES
9 PRODUCTIVITY
2/6 Did job on time
2/12 Kept on working
a. Failed to do assigned task; b. Took more time than necessary e. Slowed down unnecessarily; d. Worked at uneven tempo; e. Interfered with production line progress; f. Stopped equipment unnecessarily
A. Worked efficiently despite obstacles; B. Was outstanding in the performance of his job; C. Avoided an opportunity to slack off.
Finished job on time despite new construction
Did not stop machine during minor construction
10 DEPENDABILITY
2/10 Checked parts
2/11 Told foreman when job would be done
a. Left work without leave; b. Was late for work; c. Stopped before quitting time; d. Took excessive relief; e. Failed to report for overtime work; f. Loafed at or between jobs; g. Did personal work on job; h. Neglected assigned task.
A. Did extra work during idle period; B. Anticipated and notified foreman that he would be out of work.
Checked parts while machine was being repaired. Saved time.
Notified foreman job would be finished in two hours
11 ACCEPTING SUPERVISION AND ORGANIZATIONAL PROCEDURES
2/5 Work table
2/2 Refused to try new method
a. Refused criticism, advice; b. Opposed instructions; c. Ridiculed foreman; d. Objected to, avoided, refused job change; e. Neglected to change work, equipment; f. Was careless with materials, equipment; g. Kept area dirty, unworkable; h. Violated safety procedure; i. Distracted co-worker from job; j. Objected to, disobeyed shop rules.
A. Displayed unusual cooperation; B. Accepted disliked job without complaint; C. Accepted job change without resistance; D. Performed careful checks; E. Careful work reduced scrap, equipment damage; F. Salvaged parts, equipment; G. Cleaned, checked equipment for repair; H. Reported unsafe condition.
Refused to try new, better method.
Work table too cluttered to do job properly

Showing a man his rating at set periods points up areas where he can improve his work, become valuable to you, himself

forgetting jobs given him. Shortly after using the Performance Record he forgot another job. Talking to him did no good. So I made an entry on red side of ledger under Productivity heading." (On incident sheets the red side is for incidents of poor performance, while the blue side is for good performance.) "I explained that many more of these forgetfulness incidents would really put him 'in the red.' Since then he hasn't forgotten a job or an instruction. Without the Performance Record this man would still be forgetting jobs."

2. Increased initiative. "Since using the Performance Record, one of my men who oils conveyors and blowers in two plants has been voluntarily reporting bad bearings he finds while making his rounds."

3. Improved temperament. "One employe has a nasty temper that's caused embarrassing incidents. Since entering these on the red side of his Record, we have talked about the way his temper disturbed his co-workers. Now he's improving."

4. Improved motivation. "One of my men was above average in most respects. When shown the blue (effective performance) incidents on his Performance Record, he determined to show himself outstanding in every way he could. Fact that he knew his good qualities were recognized is helping him do still better, if that is at all possible."

5. Improved supervision. "I had considered one employe about average for his job. But after keeping the Performance Record several good qualities I had taken for granted became apparent."

Case histories. Besides the efficiency improvements caused by a supervisor's employe-development communication with people already on the job, the Performance Record has other everyday uses for the plant supervisor. All reports from companies using this program cite specific examples of the way Performance Record information has been a basis for making personnel decisions. From the maintenance-division report above, some case histories are briefed below. These are good examples of how to hold performance at high level during unavoidable phases of employe turnover.

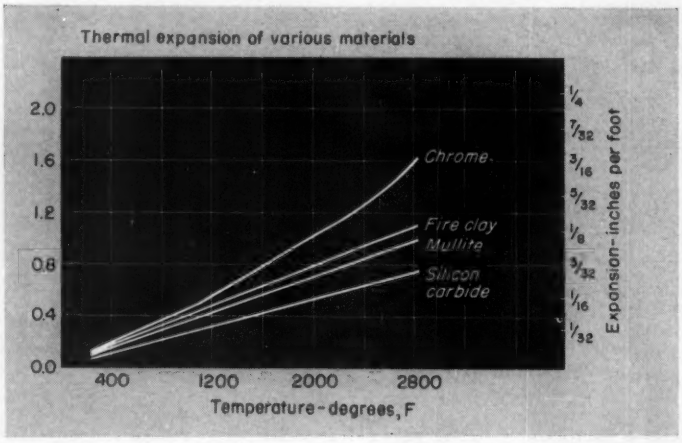
1. Transfer problems. "A new-type feeder was to be installed on an old machine. But regular journeymen on this shift were very busy. Only available man was a transfer into the department. He was new to most jobs. In checking his Performance Record from his previous foreman, I noted favorable entries, showing he caught on quickly. On this evidence, I gave him the assignment at once instead of delaying. He did a fine job and pulled us out of a hole."

(*Continued on page* 204)

OPERATORS' NOTEBOOK 99

Know where to use

Characteristics



► SILICON - CARBIDE REFRACTORIES are used for furnace lining because these materials are spall and abrasion resistant, withstand higher temperatures than other materials for this purpose. Pure silicon carbide does not soften or deform below 4175 F. Result is higher furnace temperatures without slag penetration to cause flyash to collect on surfaces.

Under standard ASTM load-bearing test of 50 psi at 1500 C, silicon carbide shows no deformation. Its modulus of rupture at 1250 C is 3300 psi, making these hot-strength values much higher than for other refractories. Mean thermal expansion values, compared with mullite, fire clay and chrome, are shown in the chart. Because of this low rate of thermal expansion and high thermal conductivity, spalling and cracking are greatly minimized.

Thermal conductivity is about eight times greater than for fire-clay refractories. Advantage is in air-cooled walls and watertube protection. Here, areas that do not need high thermal conductivity can be backed up with lower-cost materials. A smart engineer can save money by using this material in areas causing trouble.

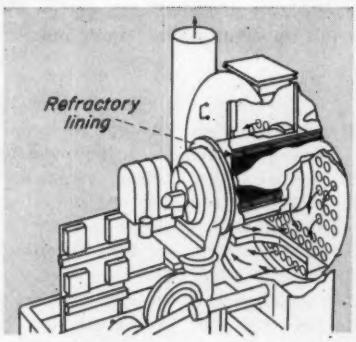
Silicon carbide is extremely hard at both room and high temperatures. It is especially useful where moving fuel beds and severe flame erosion are a problem as shown in illustrations.

—Courtesy, Norton Company. Refractories Division, Worcester, Mass.

Other uses

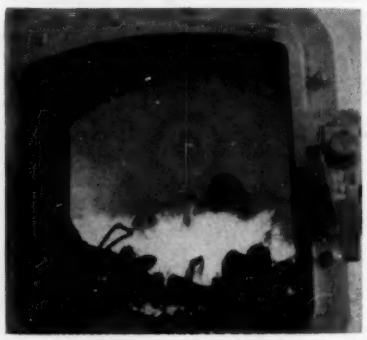
Ramming and patching

High temperature cement above is for rammed burner rings, floor coverings, protection around waterwall tubes, armor-block capping and for general maintenance. It has air setting properties that impart a high dry strength to rammed shapes without encountering any intermediate softening range. This high strength at low temperatures eliminates burning-in or sintering before the boiler is placed in service. One available product is shipped with right moisture content for immediate use.



Segmental linings

Refractory linings are used in the firetube of packaged firetube boilers, as shown. Here, lining supports combustion and protects the metal jacket in this critical area because the firetube is not watercooled. Refractory segments are tongue-and-grooved for smaller boilers; large ones use arch brick. Be sure to fit these linings with expansion space between metal rings. This high-temperature material gives better flame control with negligible spalling and eroding caused by the fuel.



Incinerator lining

Silicon carbide is a must for incinerator lining in furnace areas. Here you need great resistance to slag caused by bottles, cans and other abrasive refuse. In incinerator above, special shapes are used around the access door and interior of furnace, also in both solid and checkered construction to make up the baffle walls in the settling-out area. In baffle walls, it reduces erosion from flyash, withstands heat to 3050 F, boasts a high resistance to erosion-corrosion. Maintenance is greatly reduced.

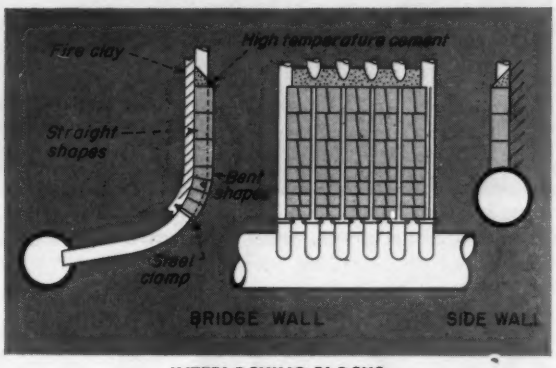
your super refractories

By STEVE ELONKA, *Associate Editor*

Watertube protection

BEFORE

NOW



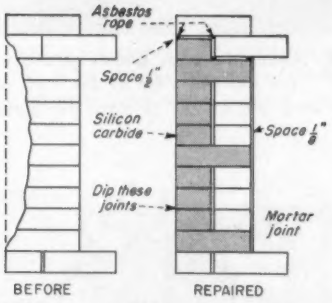
INTERLOCKING BLOCKS

Because of high thermal conductivity, silicon-carbide refractories are used to protect watertubes. Their uniform heat transfer to the tubes prevents burnouts from localized flame impingement. This protection cuts down high heat losses, but is only possible with these super refractories.

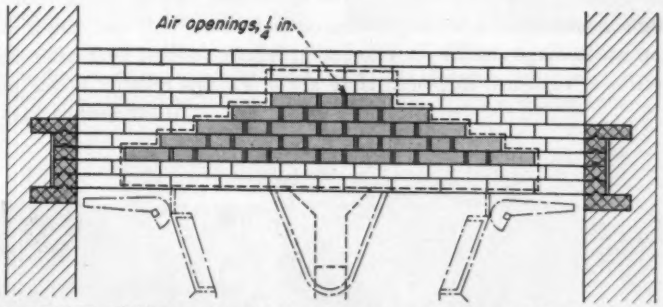
Another advantage is that high heat release from hot face material supports combustion of fuel to give a more stable operation at low loads. These features add up to long tube life. There are many interesting applications.

The bonded shapes shown fit around tubes, are mechanically strong because of their extreme hardness and high density. Result is that troublesome upkeep of tubes, abraded by moving fuel beds, is reduced. Clinker accumulation is also cut down and clinkers can be removed without damage to refractory blocks. Interlocking block design also insures sturdy wall construction. Sketches show how interlocking design does away with need to cement blocks to hold them in their place. These features cut down installation time.

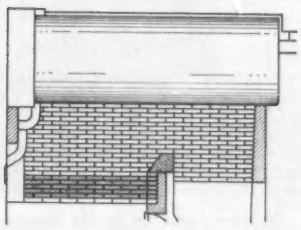
Solid-wall protection



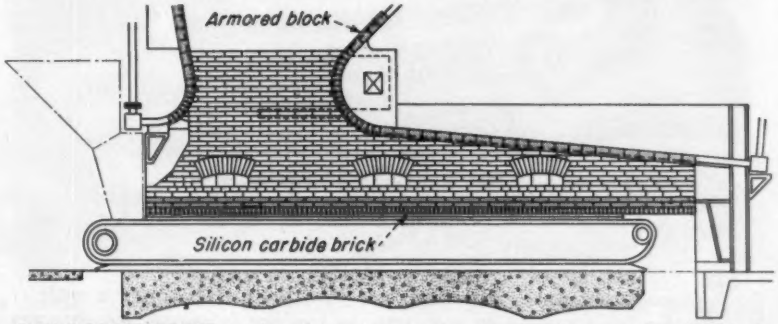
WALLS, burned and eroded, can be saved by lining old walls with silicon carbide



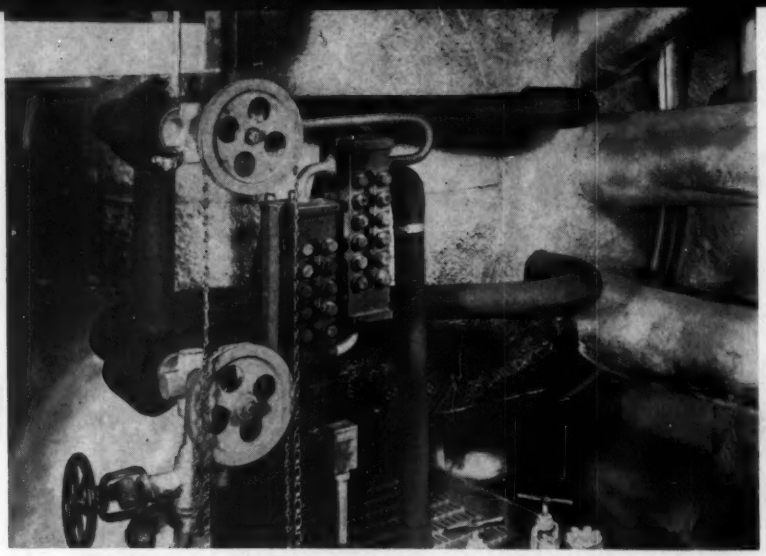
SINGLE-RETORT BOILER, stoker fired, has tongue-and-grooved silicon-carbide lining in trouble area. Air passes behind setting and through openings between bricks



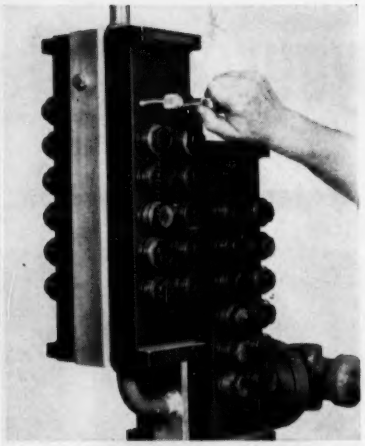
HAND-FIRED BOILER has five courses of silicon carbide above the grate line



CHAIN-GRATE BOILER, stoker fired, has severe abrasion from moving fuel bed. Water front and rear arches of this design must be protected from hot swirling gas



HIGH-PRESSURE flat-glass water-level gage with double insert. This gage is on a boiler in a central station. Other photos on these two pages show servicing work



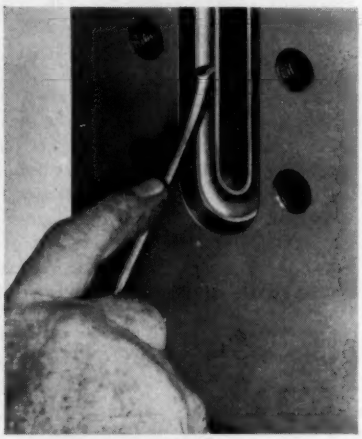
1 Shut the gage valves and open drain. Loosen cap screws, working toward center of cover. Replace with guide pins

Overhaul h-p boiler water gages right

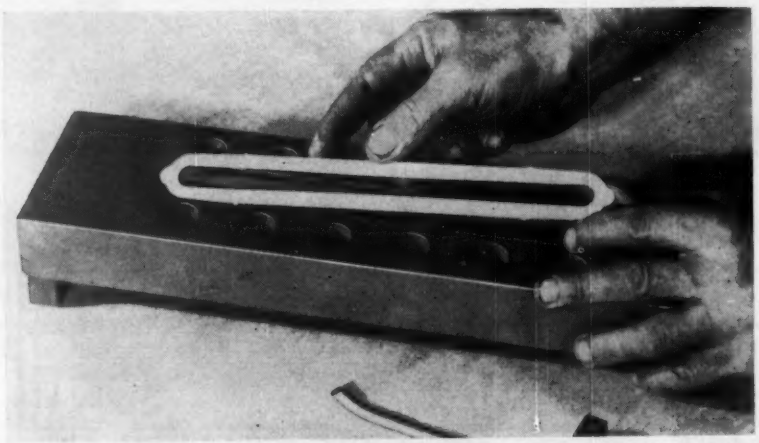
By **FRANK PTACEK**, *Mechanical Engineer, Yarnall-Waring Company*

▷ STEPS SHOWN HERE apply particularly to a mica-protected pressure-sealed flat-glass insert gage for pressures above 400 psi. Note the following about the procedure. Complete repair of the insert can be made in a short time with the insert body hot and in position on the boiler. Only one man is needed for the work. Gage can be cut into service about one-half hour after the last cap screw is tightened in place. Here are a few tips relating to the photos.

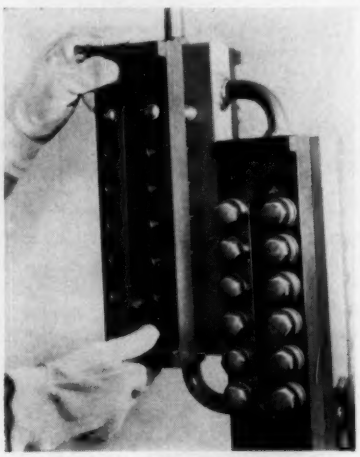
(*Continued on page* 193)



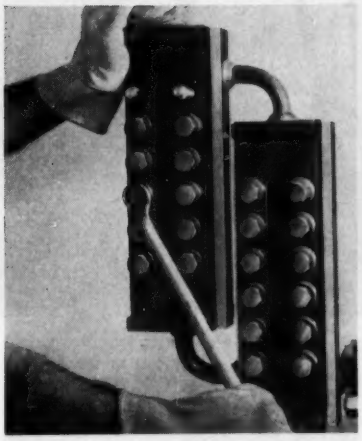
5 Clean the body gasket groove with the rounded edge of the tool. Use square end of tool to clean flat surface



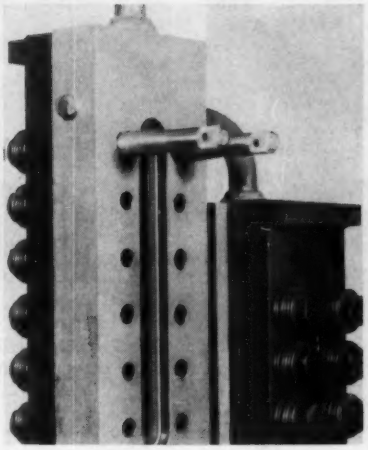
8 Press new cover gasket into the recess in the cover. This gasket is made of aluminum alloy covered on both sides by Fiberglas to provide the necessary cushioning. Gasket has six extensions to hold it firmly in cover during overhaul



9 Register cover on guide pins; firmly move into place with weight supported on pins. Tighten middle screws

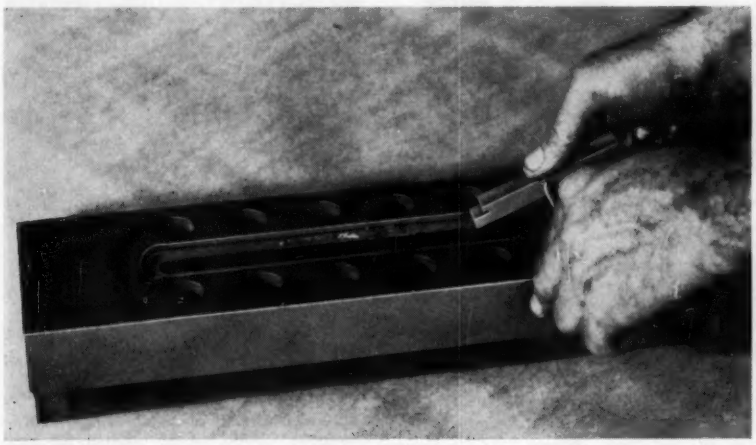


2 Remove the cover from the insert body using the guide pins. Also remove gasket, glass and mica; see Fig. 10

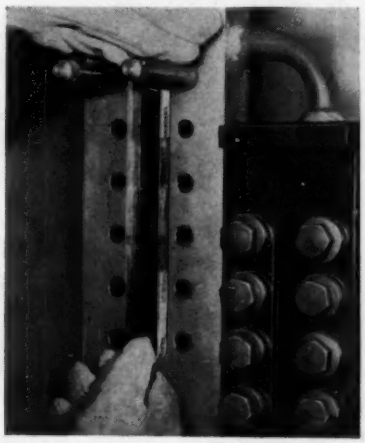


3 The gage is now ready for removal of the molded body gasket, which can be seen at the edge of the opening

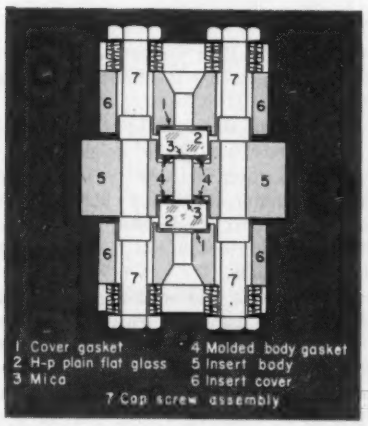
4 Loosen the molded body gasket with slotted handle of the gage tool and remove the gasket from the body of gage



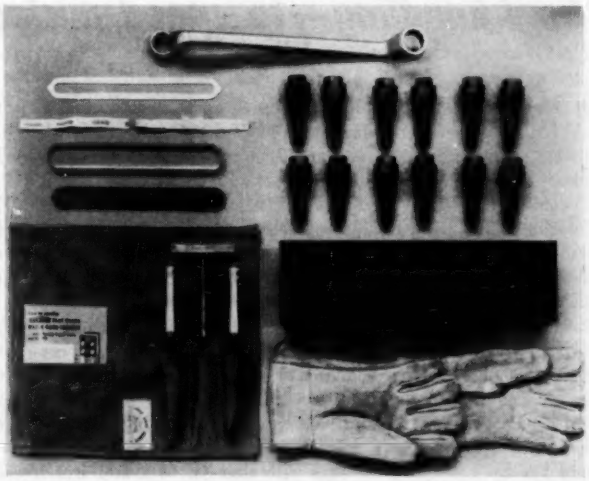
6 Scrape the gasket face of the gage cover using the square end of the tool in Fig. 4 and 5. Also clean the body faces around the cap-screw holes with same tool. Wipe or blow these surfaces clean of all dirt and other particles on them



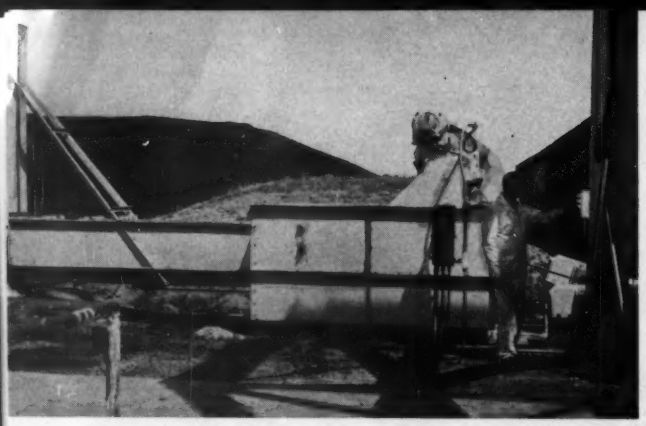
7 Apply molybdenum-disulfide to body gasket groove and screw threads; insert glass in place in body after gasket



10 Cross section of flat-glass type of water gage, showing the various parts that are given attention in servicing

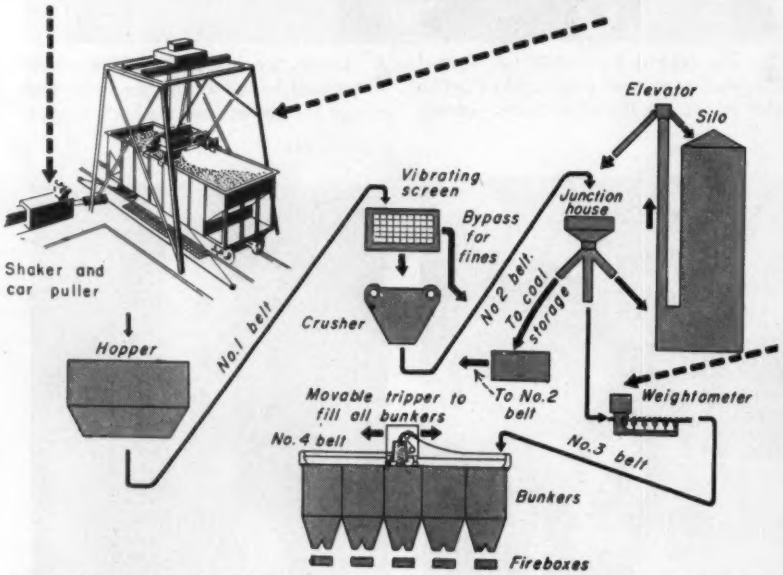


11 Insert parts which have been handled and the tools used to perform the maintenance work described by the photos here The tools help you do the job much better and more rapidly

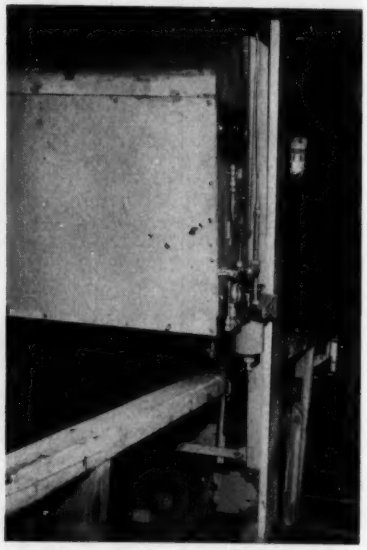


CAR PULLER quickly spots coal cars over track hopper. Old method tied up stockpile operations while bulldozer moved cars

CAR SHAKER unloads up to 350 tons per hr, eliminates clean-out by shoveling, ends bottleneck caused by wet or frozen coal



MODERNIZED coal-handling system meets double steam demand at Hanford atomic-fuel production plant. Flexible, it moves coal to and from storage, silo, bunkers



WEIGHTOMETER, an integrating, recording scale, weighs all coal sent to bunkers

Coal handling—to speed nuclear fuel production

► FOSSIL FUELS can't hold a candle to nuclear as an energy source. But without the fuels we've used for years, the infant colossus, atomic energy, wouldn't be flexing its muscles. And as expansion of our atomic-fuel production plants becomes necessary, the importance of conventional fuels, handling and firing equipment comes sharply into focus.

To engineers operating the plants, expansion presents a familiar problem: How to select and install new equipment, how to tie it in with existing units for top efficiency at lowest cost.

Fred Cox Jr, Supervisor, Hanford Atomic Products Operation (General Electric Company) puts it this way: "Plant expansion almost doubled our steam load. We put in new boilers to meet the demand. This meant revamping our coal-handling system. We'd been moving cars with bulldozers and having men clean the cars with shovels. Wet and frozen coal took time. We couldn't fool around with that now.

"First we put in a car puller and shaker. Increasing speed of No. 1 and No. 2 belts and widening No. 2 belt doubled their capacities. A vibrating screen on the inlet chute kept wet coal moving. Bypassing the fines solved crusher overloading.

"We built a 640-ton silo to hold coal for weekends and holidays. A new recording scale weighs all coal sent to bunkers. A change from friction to motor drive on the under-bunker distributor car and a change to a chain-type under-bunker flight conveyor doubled capacity.

"The electrically interlocked system has a master control panel in the boiler room. We can move coal as we please from hoppers to bunkers, silo or storage. One man controls coal flow from silo to bunkers. This cuts out overtime on weekends. The old system would have needed the full crew every weekend plus extra hours in bad weather.

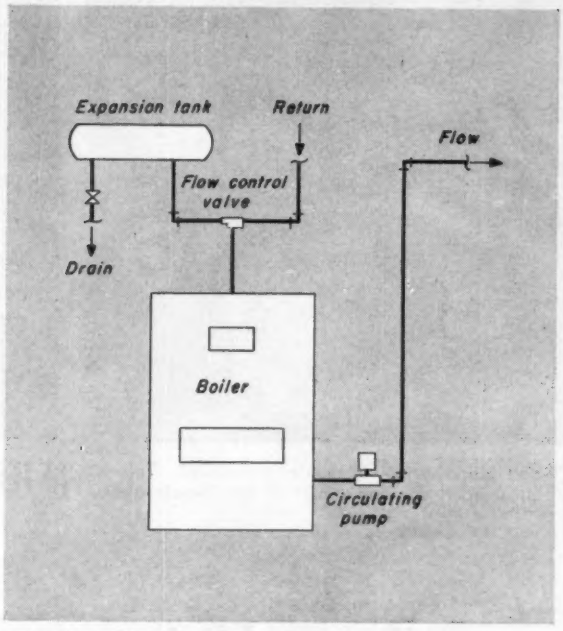
"Big saving is in the automatic controls. We can even dump the silo in an emergency (hot coal or fire) without using the belts. We're moving more coal in less time with fewer men. Savings in safety and reliability can't be measured in dollars—but add to the return on our investment."

HEATING

If your hot-water heating system gives you the bleed-and-drain blues, try . . .

Reverse flow to keep air out of radiators

By CHARLES J JAHNE
Mechanical Engineer



REVERSING USUAL FLOW in loop or 2-pipe system puts boiler on suction side of pump. Returns enter at top of the boiler

► IT SEEMS ODD to say that a cool radiator makes people hot. It does, though. Hot under the collar. Airbound radiators in hot-water heating systems steam up the engineer responsible for operation and the people who feel the chill in the area that's supposed to be nice and warm. The last named have the urge either to make loud noises over the engineer's phone or to bang on the offending unit. Neither method is conducive to warming the cockles of his heart—or the radiators.

Regardless of whether it's an open or closed system, the first step in getting the radiator back on the job is one the maintenance man could do in his sleep. He wearily sets out with key or wrench—and an old tomato can. The key or wrench to open the radiator vent, and the tomato can to catch the squirt that follows the sizzle. With an open system, he's done until the next time. But if he's got a closed system, chances are he has to go down and drain the expansion tank to boot.

Most modern systems are the closed, forced-circulation type. This prevents loss by evaporation and danger of freeze-up, permits higher pressures by raising the boiling point—mighty desirable features. Air is necessary in this system. But only in one part—the expansion tank. Trouble is, it doesn't stay there. For a number of reasons, familiar to engineers, it finds its way from the expansion tank to radiators and convectors. Some air comes in with makeup, and little leaks do their part. Sooner or later we get around to the bleed and drain routine.

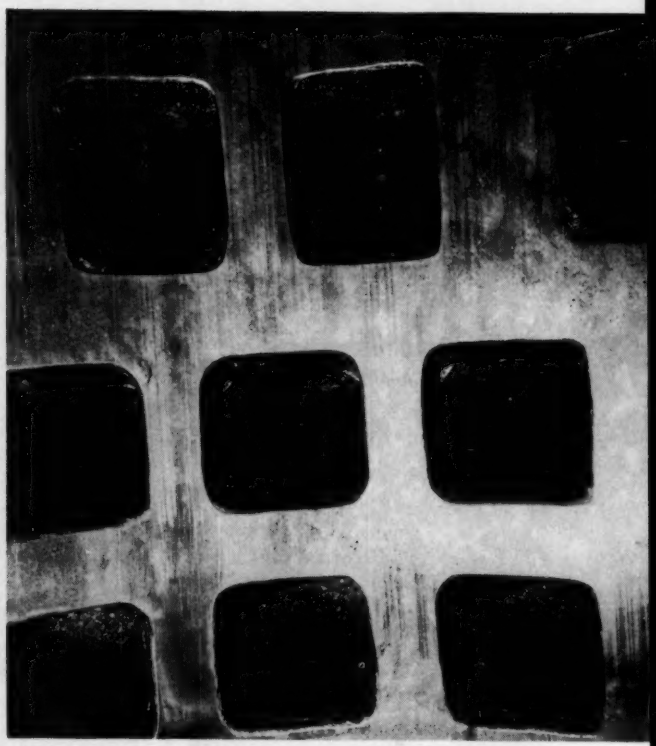
Reverse flow, Fig. 1, may sound like a radical departure from accepted practice. It is. But it helps lick the airbound headache—and without a lot of fancy fittings. In reverse flow, the hot water travels a course just the opposite of that in a conventional system. The circulating pump pulls the water from the boiler, sends it out to the radiators. Returns come back to the top of the boiler. It doesn't matter if it's a loop or a 2-piece system. Since the radiator doesn't care which way the water goes through, direction of flow is no problem. If it's a one-pipe loop, distribution fittings may be used. Where they're located isn't important so long as they keep the water flowing in the right direction and don't cause any restriction.

The reverse flow method can be used with any existing system. Few changes —and those inexpensive — should be necessary. Reverse the circulating pump so the boiler is on the suction side. Bring returns back through a flow valve on top of the boiler. Electrically connect the circulating pump, flow valve and building or room thermostats in series. The flow valve won't open unless the pump is running, and the pump won't run unless a thermostat is calling for heat. Opening the flow valve *may* draw some air from the expansion tank into the boiler. But with the pump pulling from the bottom of the boiler, the air doesn't stand much chance of getting into the system. It will return to the expansion tank where it belongs.

Properly filled and checked for leaks, the reverse flow becomes a truly *closed* system. Without changing its position, the expansion tank is automatically connected to the return rather than the flow side of the boiler. It still protects the system from surges, but no air can be forced into the water stream. Further, since it's good practice to introduce feedwater into the boiler through the return piping, any entrained air simply bubbles off and goes to the expansion tank.

Reverse flow gives a simplified system devoid of extra fittings. In changing an existing system or designing a new one, reverse flow ends need for repeated venting and adding water.

BEFORE Port blocking by carbonaceous material. This is a condition sometimes met in the 2-cycle diesel



AFTER Same type of engine as at left after using a fuel-oil additive for one year. Note how clean ports are

How additives can make your residual

► RESIDUAL FUELS, also called No. 6 oils and bunker-C, are truly the residue from the crude oil remaining after gasoline, kerosene, heating oils and diesel fuels have been removed at the refinery. Most of the compounds of sulfur, vanadium and sodium remain in this residue. In effect, there is a far higher concentration of these harmful compounds in the residual than there was in the crude oil itself.

Sulfur problems have been recognized by engine builders and operators for many years. Most diesel builders recommend, when you use a 1% sulfur fuel, that a Supplemental List I or Series II lube oil be chosen for the engine. By comparison, a 1% maximum sulfur fuel might be considered good, when you recall that many residual fuels contain 3 to 3½% sulfur. So a No. 6 fuel of 1% maximum sulfur commands a premium from 15 to 25c a barrel, when available. Exact premium varies with the location.

Unfortunately, even 1%-maximum-sulfur No. 6 fuels may contain much vanadium or sodium, or both. Compounds of these elements can be seriously harmful to certain parts of diesel engines, gas turbines and boilers.

Wear rates of cylinder liners and piston rings may be as much as three times as high with residual fuels, or blends, as with straight diesel fuel. Though engineers disagree on the cause of wear—corrosive acids formed during combustion or the harder carbonaceous sulfur-containing deposits—sulfur oxides are bad actors.

Sulfur trioxide is responsible for most of the deposits and corrosion. When it is reduced to sulfur dioxide, there are far fewer troubles from these causes. This is true for diesels, gas turbines and boilers. An additive can be introduced into the fuel oil that causes the reduction of sulfur trioxide to sulfur dioxide, with a consequent lowering of the dewpoint.

Vanadium and sodium. Damaging effects from these two elements are now well known. Vanadium, as the pentoxide, and sodium, as the sulfate, are known to be extremely corrosive to even high chrome steels at temperatures in the 1200-F range.

Corrosion problems caused by these compounds are not confined to any specific application of residual fuels. In gas turbines burning residual fuel, the rotor buckets and nozzles are likely to be corroded by minute quantities of vanadium or sodium, or both, present in the fuel. Operators of oil-fired boilers have long faced the serious problem of corrosion attack of steels, including alloys, in superheater tubes, spacers and hangers. This corrosion is accompanied by slag deposits, which cannot be removed by air or steam soot blowers.

Diesel-engine pistons, photo above right, often suffer wastage of the metal in the head, resulting in cracked pis-

By R S NORRIS, *Fuels & Lubricant Consultant*
R S Norris & Associates

PISTON HEAD shows metal wastage traceable to using a residual fuel in a diesel. Additives can stop this

fuels burn better, cleaner

tons. While this is often passed off as "burning," from improper functioning of the injectors, inspection reveals pitting, corrosion and vanadium deposits. Likewise, a close look at exhaust valves and flame rings, from certain types of diesels burning heavy fuel, shows the same conditions.

Recognizing that these oil-soluble elements are present in the fuel and cannot be economically removed, one approach is to render them harmless in the process of combustion. Acids of the sulfur oxides can be neutralized by the presence of alkaline-earth metals, available upon combustion to react with the sulfur compounds.

Vanadium and sodium compounds are corrosive only when in a liquid or a molten state. So it is possible to cause them to pass harmlessly out the stack by introducing into the fuel an additive that combines with the vanadium and sodium compounds to raise their melting point. A group of additives, known commercially as BARSAD, perform these functions and hold some promise for operators of diesels, gas turbines and boilers burning heavy fuel.

Where sulfur acids cause trouble, these additives are generally alkaline-type compounds. Aluminum and silicon compounds are effective in minimizing corrosion due to vanadium and sodium in the fuel. Typical primary materials successfully used to date include magnesium, barium, calcium, aluminum and magnesium - silicon. These are generally used singly, but combinations are also applied, depending on operating conditions and fuel.

Case histories. These additives have been used in more than 20 motorships burning heavy fuels, some for more than 18 months. Three, powered by 9-cyl 2-cycle 25 3/16x45 11/16-in. double-acting Fiat engines, suffered metal wastage of the flame rings in the lower combustion chamber and corrosion of the piston heads. Since using the additive, both these conditions have been brought under control.

One of the most gratifying results in all these motorships is the cleanliness of the intake and exhaust ports. The deposits burn out of these ports because these additives contain relatively high percentages of metals in oil-soluble form. They act to lower the surface ignition temperature of the carbonaceous deposits.

Steam boilers. Tests for 23 weeks on a Foster Wheeler type SA 650-psi 825-F 150,000-lb-per-hr boiler also show promise. Operators of this unit always had a slagging condition on the superheater and waterwall tubes, often bridging between the tube rows. Even more troublesome were the air-preheater deposits. They were wet, black, highly acidic soot that packed the preheater section, also causing corrosion.

During the test period with the additive there were still some deposits in the superheater section, but it was observed that the porous scale clung to the tubes only in small areas. The scale could be easily brushed off by hand during the inspection. Preheater deposits were dry and powdery. Soot blowers, recently installed, will, it is believed, remove the deposits easily and keep them under control.

Similar conditions were noted in a boiler of a C-2-type cargo vessel. The chief of this ship reported he found it necessary to blow tubes only once instead of twice daily. Also, the soot and corrosive byproducts of combustion from the stack were minimized. Another troublesome problem that was eliminated by using the additive was burner failures caused by slugs of water present in the fuel. The water came from ballast not removed from the tank prior to bunkering. By emulsifying the water into the fuel, boiler-burner failures are prevented.

Corrosion problems still exist—not all of them have yet been solved. But it is this writer's opinion that an easily applied oil-soluble additive holds more promise than the injection of materials, such as dolomite, kaolin, magnesia and the like, into a combustion chamber. While the additives discussed in this article have proven themselves in service they are not a complete panacea for all operating conditions met in service.

Conditions vary from one plant to another and from one engine to the next. Only by study and tests can you evaluate the relative merits of a given method for making a fuel more agreeable to an engine. The writer feels that particle size and intimacy of contact between the metallic portion of the additive and the vanadium and sodium of the fuel ash are of importance.

Refrigeration's No. 1 problem

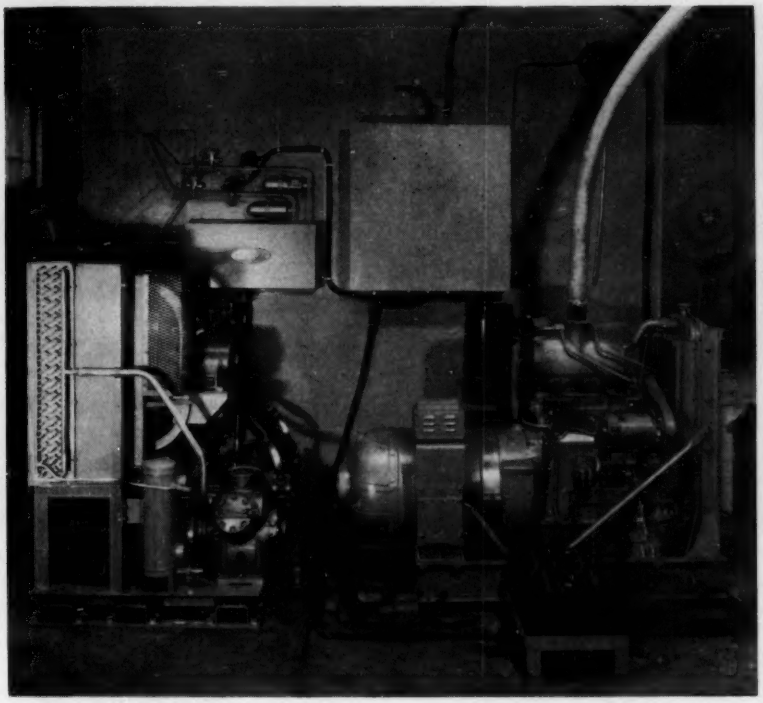
Sure, you know moisture's in the system when you have a freeze-up. But what happens when you don't get that warning? Here's the low-down on how to avoid a breakdown

By JOHN BOPP *Ansul Chemical Company*

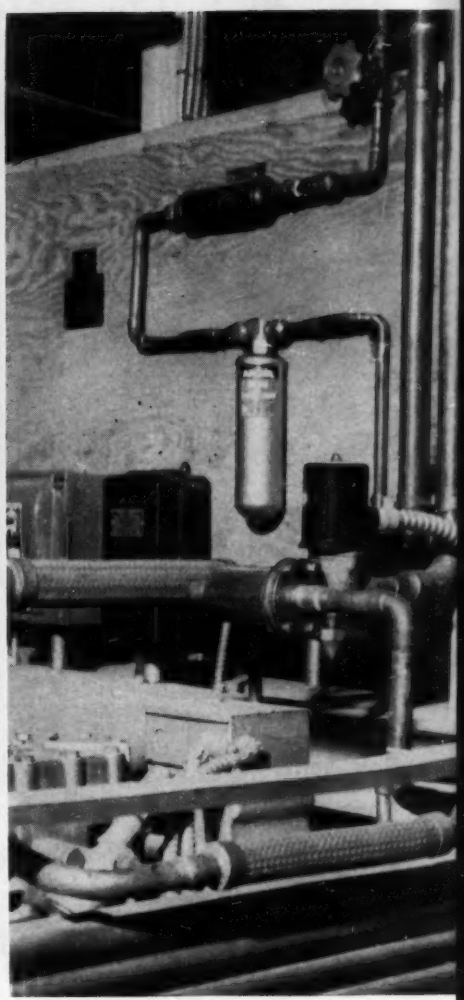
► MOISTURE is the No. 1 enemy of refrigeration systems. It can sneak in like a thief in the night. In insidious fashion it pursues its destructive course unseen and often undetected until the engineer sees its effects. Even then, he may be tricked into treating the symptoms rather than the cause. Once in, moisture is mighty tough to get out. Experts estimate that almost 80% of all system breakdowns can be traced to it.

Drying a system is a must if a breakdown is to be avoided. Let's take a look at what moisture does. First, at low temperature, it freezes, turns to ice. Result: Freeze-up of expansion valves, capillary tubes, evaporators. These in turn can cause serious trouble or breakdown. Second, it forms acid, which forms sludges that clog lines, valves and tubes. Sludges make the compressor work harder and *hotter*, which means more moisture, more acid, more sludges, more trouble.

Rusting is the result of free water in the system. Too, since many common refrigerants hold little free water in solution at expulsion-valve temperatures, we're warned of the presence of water by a freeze-up. But if only a little moisture is present, or low-side temperature is above 32 F (air conditioning, for instance), we don't get the warning freeze-up. Instead, the slow but deadly attack of "acid corrosion"



LAYOUT of typical mechanical railway refrigeration unit. Keeping system moisture-free is a big factor in required dependability for transport of perishables



INDICATOR FITTING of the drier unit mounts in easily readable position. The window contains an element that changes the color depending on moisture content

SIMPLIFIED CARTRIDGE CHANGE, with drier mounted in any position, needs no valving. Old cartridge screws out, new one in. Hand tightening gives leakproof seal

—get it out of your system

begins because many refrigerants form hydrochloric acid when in contact with moisture. And it's almost never detected until real damage is done.

Extent of corrosion depends on (1) the amount of acid (2) temperatures and (3) length of time the system operates in an acid-forming condition. Hydrochloric acid reacts with iron and copper, forms iron and copper chlorides. Iron chlorides only, in the system, mean corrosion has just started. Presence of copper chlorides indicates considerable corrosion because copper and the acid have a slow reaction rate.

Insulation breakdown in electrical areas of hermetic systems can be due to acid. Little is known about what actually causes the breakdown. Probably higher temperature complicates the action. But moisture is believed to be the real culprit because it produces the acid in the first place. With breakdowns, short circuits can occur resulting in motor burn-outs. In this excessive heat, oil and refrigerant combine to produce more acid. This causes burn-out of one replacement motor after another unless the acid is removed by thoroughly cleaning the system.

Engineers have waged battle on the moisture problem in mechanical-refrigeration systems for almost a hundred years. It's gradually being won and a new gel-type activated-alumina drier unit is one of the big reasons. It has generous drying area, because of its pellet form and, even saturated with water, it picks up more than 4.5% of its own weight of hydrochloric acid. The unit's design provides for moisture detection at a glance, (photo, p 122).

Manufacturers use corrosion-resistant materials and go all out to provide dry refrigerants and systems. The same airtight care should be the aim of the operating engineer. Moisture has the nasty habit of getting into any system despite the best of care. When it does —and nothing is done about it—the equipment is headed for the scrap heap. Beat moisture to the punch by knowing *when* it shows up and *how* to get rid of it quickly. Let's get started now.

Ray Seitz, plant engineer at Chas Pfizer & Co, Brooklyn, solves his mechanical-power-transmission problems the easiest way. His formula . . .

Regular maintenance + adequate spares

► "WE RARELY HAVE any special problems with mechanical-power-transmission maintenance," says Ray Seitz, plant engineer at the Brooklyn plant of Chas Pfizer & Co, Inc. "Weaving it in with general plant maintenance takes care of the situation.

"Our big problem is fitting the necessary equipment into the available space. This means some juggling at the design stage. At one point we even had to build a penthouse with a skylight to permit assembly and maintenance of an agitator drive. But once these initial space problems are hurdled, regular plant-maintenance routine takes care of practically all power-transmission problems."

His well-thought-out program can work for you, too. Here is the setup:

A team of four experienced lubrication and belting men under Machine-shop Foreman Gus Stracke covers the plant two to three times a week. They see that all equipment is properly lubricated, following oil supplier's recommendations. They also check belts for tension, alignment and wear, listen for unusual noises, look for hot bearings.

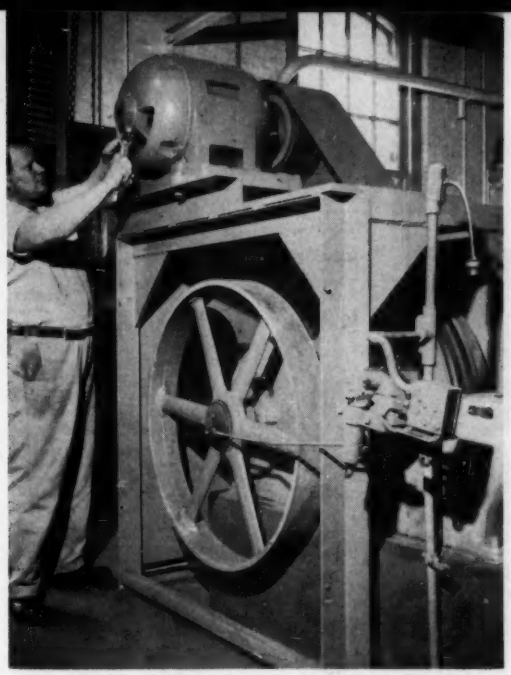
When they find trouble, they immediately report it to the department supervisor. It's his responsibility to get repairs made.

Sometimes equipment needs general overhaul. For gears in severe service, this means taking unit out of service, replacing with a spare, stripping down and rebuilding completely. Then rebuilt unit is put into spare mechanical-parts storage.

As much as possible, Seitz buys standard equipment. This cuts down spare parts' inventory, avoids headaches if something goes haywire.

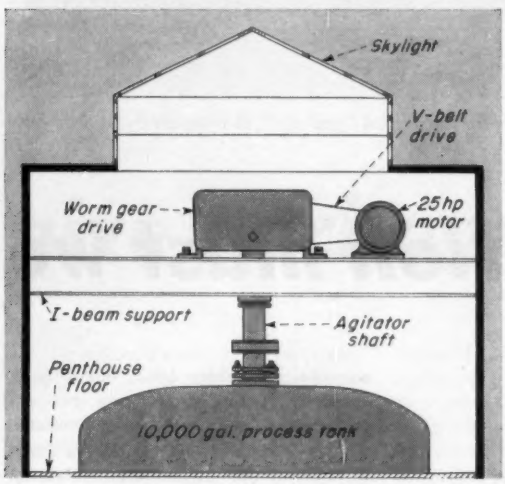
It also pays off for the other Pfizer plants in Groton, Conn. and Terre Haute, Ind. All three plants circulate a list of spare parts, so each plant knows what spares are available in the others, can call for fast help in an emergency.

Future plans call for setting up an inventory of plant equipment, with a check list of what repairs are made to each piece. This will cut down need for relying on memory when deciding whether it is time to replace units.

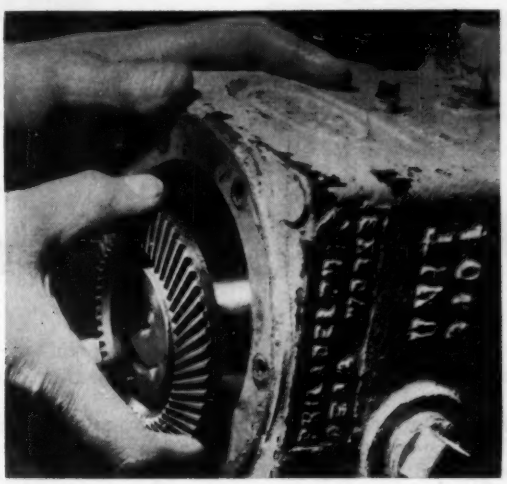


SAVING SPACE is major problem all through the plant; 30-hp motor driving this compressor was moved from floor to present position to conserve aisle space. New units are purchased with the drives mounted on top

LUBE AND BELTING storage room is focal point for preventive maintenance. Oilers start out here, cover entire plant 2 to 3 times every week. These men also check for loose belts, unusual noise, hot bearings

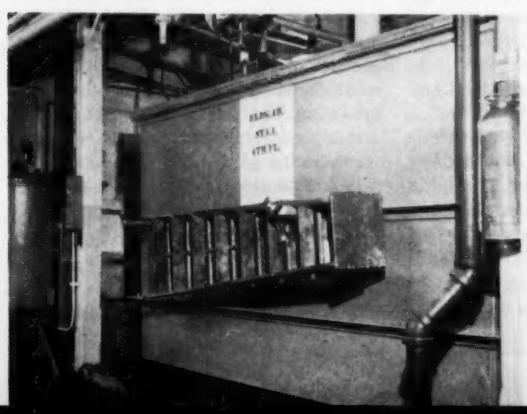


LOW HEADROOM above large process tanks requires ingenuity to provide for power-transmission maintenance. Here Pfizer engineers built a skylight in the roof so the shaft and agitator blades can be removed

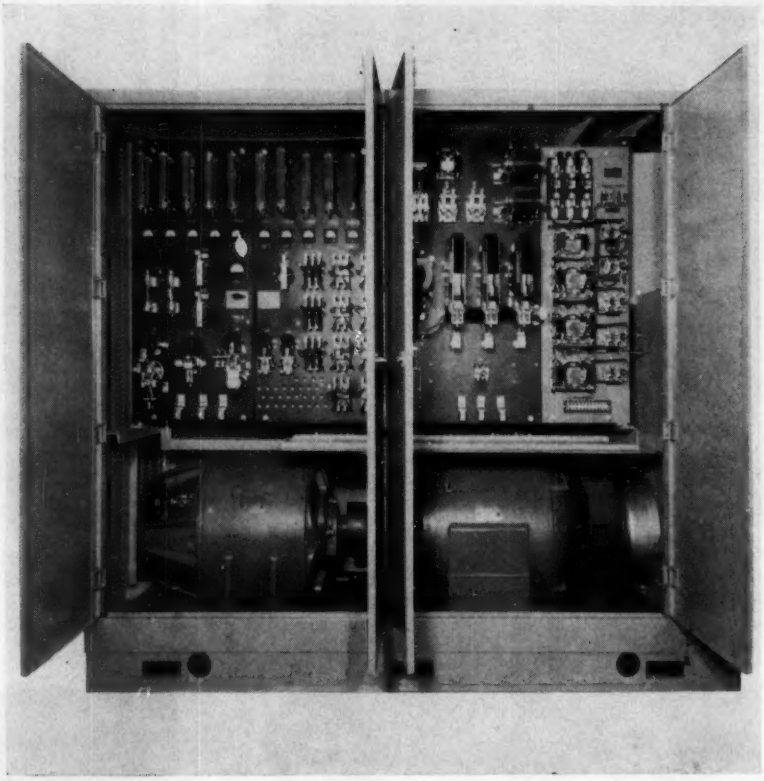


GEARS get complete overhaul when necessary. Unit is replaced by a spare so production continues. Then millwright shop strips it down, replaces worn parts, reassembles, sends it to spare mechanical supplies' room

LADDER STATIONS near point of use eliminate extra trips, save maintenance crew's time. There is at least one such station on each floor of each building in the plant. Safety department inspects all ladders monthly



EASY ACCESS to transmission equipment in out-of-the-way spots saves many potential headaches. Here mechanic checks bearings on head frame of box conveyor running over roof from packaging to storage dept



MOTOR-GENERATOR and controls in typical "package" of a variable-speed dc drive

How much attention must we

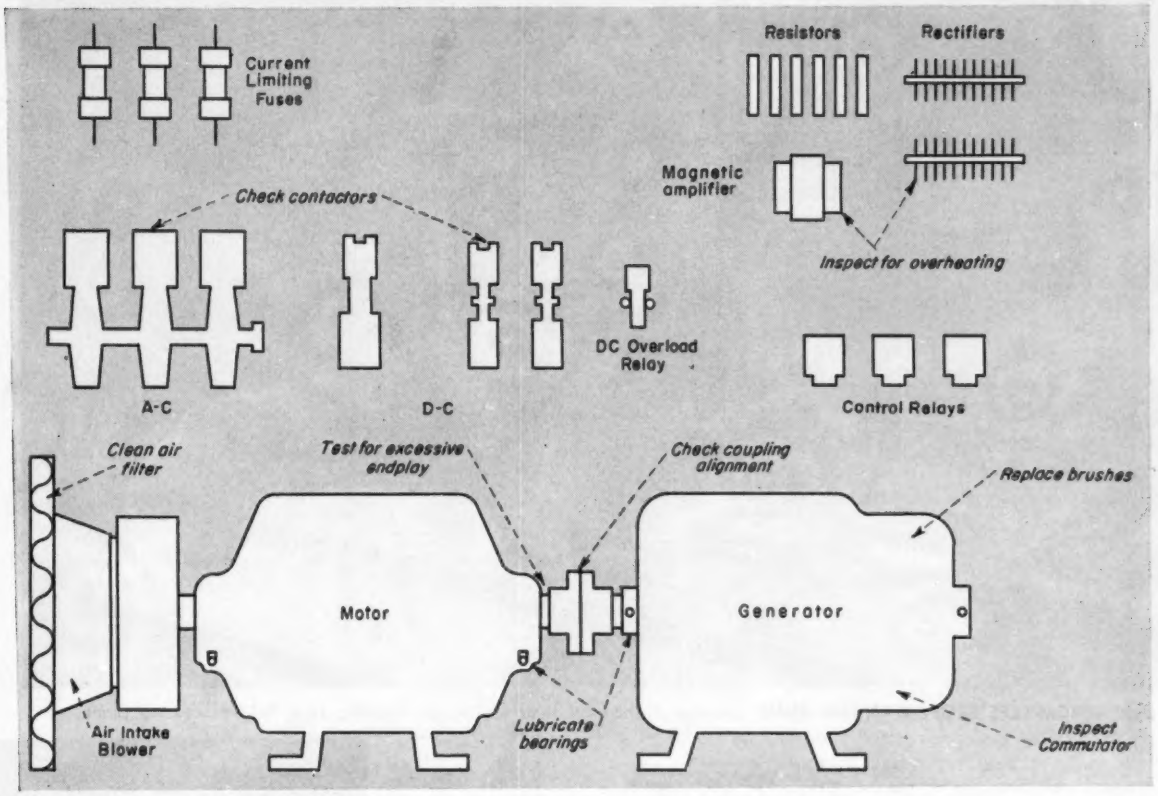
Dc motors are coming back into the plant because more present-day machines require a wide range of speeds. Packaged power and control units provide dc on the spot

► As more and more industries get in line with automation there'll be greater need for electric motor drives with wide speed range. In the one-hp to 200-hp class, demand is being met by packaged dc drives. If you don't have any in your plant now, chances are you'll have one or more to take care of in the near future. Variable-speed drive consists of separately excited dc motor, control station and the "package" that contains ac-to-dc conversion equipment, controls, overload and short-circuit protection, etc. Some manufacturers use rectifiers in smaller sizes (3 hp and under), but most packaged drives contain motor-generator sets to produce dc. Packaged drives are designed for as little maintenance as possible, but where there's dc equipment good maintenance is a must if you want to stay out of trouble. Units are built with easy installation in mind, too. Motor-generator bases are part of enclosure, and usually don't have to be bolted down. With most models you wire directly to terminals of units since starters and protection are included.

What you can do with drive depends on the particular model. Most manufacturers design drives on the "building block" principle. Drives can be modified to give you many combinations of control by using different control subassemblies. Besides basic motor field-resistance speed control you can get armature voltage control, or combination for widest speed range; regenerative and dynamic braking; reversing and jogging. Some manufacturers offer optional electronic control that provides close speed regulation, extra-wide speed ranges, torque limitation and controlled acceleration and deceleration. Control devices for constant-tension calendering machines are easily incorporated. Multi-motor drives are available where several motors are driven by the same "package."

Easy maintenance is feature of the packaged dc-drive design. The "building block" method enables you to replace parts quickly and get drive back in operation. Cabinet designs are such that motor-generator sets are easily removed for servicing when necessary. Let's take a look at major parts of a system and see what regular maintenance you'll have to give them.

1. Air intake. The packaged drives



MAINTENANCE of package-drive power units calls attention to brushes, commutators, bearing lubrication, cleaning air filter

give packaged dc drives?

are forced-ventilated or "pressurized," usually by blower on motor-generator shaft. Some packages have separate blower driven by small ac motor that starts automatically with motor-generator set. All the blower motor requires is a real close look, and perhaps a few drops of oil if bearings are not sealed type. Air-intake filters need regular attention. How often they must be cleaned and re-oiled naturally depends on how dirty the atmosphere is. In a dirty atmosphere, clean frequently until experience shows how often you should do it. In a clean atmosphere, service filter at regular intervals to make sure it's not forgotten altogether. Inclosed electrical equipment depends on good ventilation for proper cooling. If air supply is cut off temperature climbs sharply. In line with this, keep a lookout that other machinery, packing cases, etc., don't block intakes and outlets.

2. Dc brushes. Generator in package and dc motor on machine have brushes that gradually wear away and must be replaced. Modern dc machines are designed so brushes are easily removed and new ones inserted, but brushes must be properly seated—shaped to contour of commutator. Since a lot can be said on this subject, maintenance personnel who are familar only with ac machines should take a refresher on brush maintenance. Take care that motor windings don't become covered with carbon dust. Watch out that brush-seating compound, if used, doesn't plug up mica segments between commutator bars.

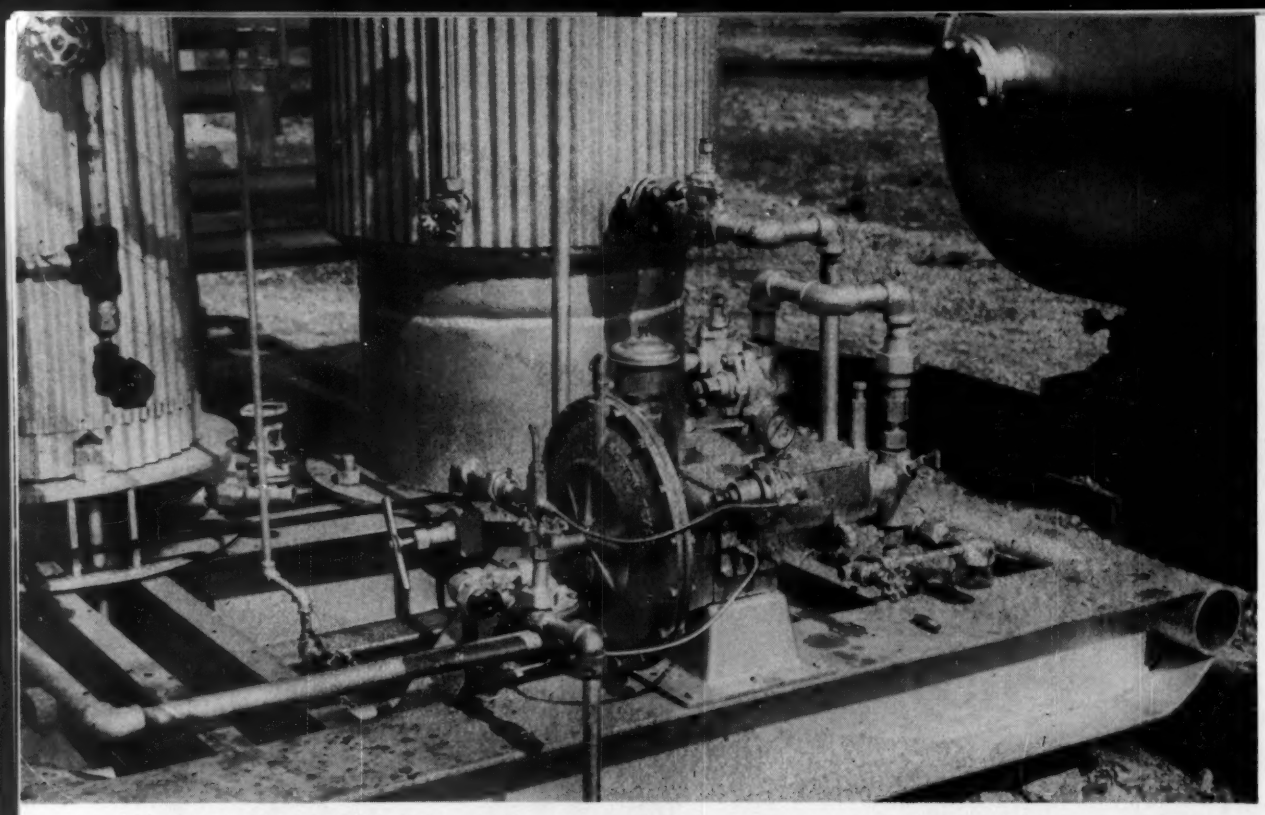
3. Commutator. Properly functioning commutator is smooth, has brown commutating film, and shows no sparking. It requires no attention for years other than to make sure undercut spaces between bars are clean down to the mica, and are not becoming plugged by dirt. Black spots or streaks, pitting and sparking are signs of trouble, perhaps indicating that commutator is grooved or out of round. Sanding or grinding in place may correct trouble, but occasionally it may be necessary to remove armature and turn down commutator.

4. Contactors. Although contacts have long life, as renewable parts they must be inspected at regular intervals. It's a good idea to become familiar with a circuit, and know the function of each contactor and relay. Stock spare coils as well as contacts.

5. Bearings. Smaller units may be equipped with sealed bearings that require no lubrication, but larger units will have standard ball or sleeve bearings that need periodic lubrication.

6. Exciter. Selenium rectifiers are most commonly used for exciting current, but some packaged drives have exciter generators that should get the same care as the main generator. Other drives use electron-tube rectifiers that require no regular care. Keep spare tubes on hand in case trouble develops.

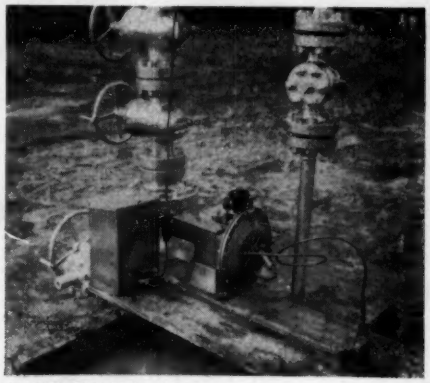
Control circuits employ elements, such as magnetic amplifiers, that don't ordinarily need attention.



DIAPHRAGM-TYPE PROPORTIONING PUMP used as a chemical injector for gas treating in a field processing plant

For best output from pneumatic metering pumps keep your power supply right

By **NORMAN H SACHNIK,** *Chief Engineer*
Texsteam Corp, Division of Vapor Heating Corporation



HIGH-PRESSURE chemical proportioning pump showing feed tank and the piping

► AIR-OPERATED METERING and proportioning pumps are popular for many services, including chemical injection, handling lubricants, hydrostatic testing, pumping corrosion inhibitors, etc. Since compressed air or gas supplies the power to drive pumps like those shown on these two pages, the choice of the supply source, pressure and temperature is extremely important. Let's see why.

Proportioning pumps, *above and top of facing page,* are designed for air or gas pressures of 200 psi or less. Discharge pressures developed range up to 20,000 psi when handling up to 68 gpd of liquid in the pump.

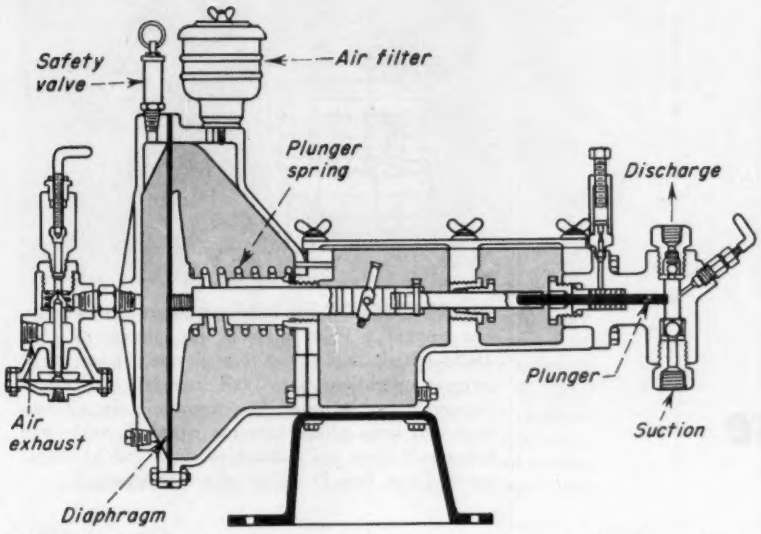
As you can see in the cross section of this unit, *top of facing page,* it is fitted with a diaphragm actuating a spring-loaded plunger. Air pressure acts to push the diaphragm to the right; the spring returns it to its original position, ready for the next stroke.

Discharge pressure developed depends on the pressure of the compressed air or gas powering the pump, and on the plunger diameter. With the pump shown, the discharge pressure is 42 times the air pressure when a 1¼-in.-diameter plunger is used. With a ⅜-in.-diameter plunger the discharge pressure can be as much as 497 times the air or gas pressure.

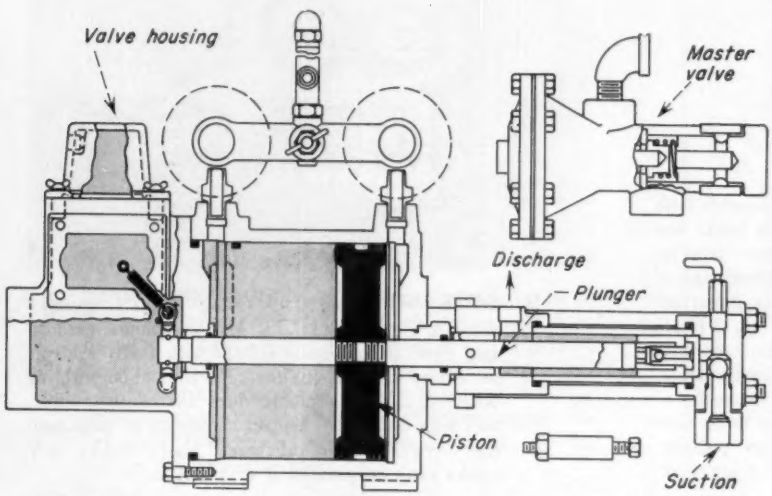
These units are furnished with a relief valve and pressure regulator. An integral bleedoff permits easy priming and sample catching.

Slugger-type reciprocating air- or gas-operated pumps, *bottom sketch on facing page,* develop pressures up to 8000 psi with power air pressures up to 200 psi. The ratio between the discharge pressure and air or gas pressure is about 50 to 1. Capacities range from 1 to 1000 gph.

As the cross section shows, this pump is fitted with an air cylinder containing a piston, to which is attached the pump plunger. As with the diaphragm-type unit described earlier, the maxi-



DIAPHRAGM-TYPE proportioning pump is powered by either air or gas at pressures to 200 psi. Unit has spring-loaded shaft actuated by diaphragm, delivers to 700 gpd



SLUGGER-TYPE reciprocating pump is built for pressures up to 8000 psi, capacities to 1000 gph. Either air or gas actuates the piston, which is attached to plunger

mum speed recommended for this unit is 50 strokes per minute.

Start-up of pumps, operated by air or gas, is relatively simple. With either pump shown here, air or gas is fed to the regulator until the pressure gage reads 15 to 20 psi, after adjusting the regulator. This is the pilot-control air or gas and does not indicate the gas pressure on the main diaphragm or power piston. An increase in this pressure will not speed up the pump, nor will a decrease in the pressure on the regulator slow down the pump. Pressure should never rise to the red section of the pressure gage for either pump described here.

Operate pump slowly until a clear stream of liquid is discharged from the open bleeder valve. When you're sure the liquid is completely free of air, close the bleeder valve and adjust the pump to its required speed.

Stroke length of the plunger can be adjusted in the diaphragm-type pump. This is done by lifting the plunger-travel adjusting pin and placing it in the hole in the plunger nearest the plunger packing gland. This position is the longest stroke. To shorten the stroke, place the pin in the hole nearest the end of the plunger. The pump is assembled at the factory with the plunger in the long stroke.

Packing in the diaphragm-type pump should not be overtightened. Packing in this pump is a pressure-sealed chevron-type. Excessive tightening of the packing will increase the wear on the plunger and packing.

If the pump stalls because the packing is too tight, loosen the gland until the pump moves. After it is moving, slowly tighten the packing gland until leakage around it stops.

Caution should be exercised in replacing parts of the pump head. If corrosion is noted in any of the parts, notify the pump builder of the type and the manufacturer or source of the liquid being handled. The pump builder should also be notified if you (1) find excessive wear in any parts or (2) replace certain parts at frequent intervals.

Trouble-shooting of diaphragm-type pumps is simple. If a unit stops with the plunger in the extreme discharge position, and gas or air is being discharged from the safety valve, or there is a constant discharge of air or gas when the safety-valve lift ring is pulled, the diaphragm of the master valve has burst. When the pump will not move forward and there is a constant discharge of air or gas from the lube-oil chamber, then the main diaphragm has burst.

When the pump operates but does not discharge liquid, open the bleeder valve to break a possible air lock. Check whether the sight-feed shutoff assembly is in the out position and also check the balls and seats for leaks.

Slugger pumps of the type shown here discharge on both the forward and return strokes. If the pump stops in the extreme discharge position and there is a constant discharge of air or gas from the exhaust outlet in the master valve, check the tripper device, the lower valve seat and the pump diaphragm. If the pump operates intermittently or stops completely, remove the pilot valve and check the flipper-arm bearing, valve disk and valve drive pin. When the pump operates but does not discharge liquid, check as above. Also check the suction-end cap and the air piston for worn or broken rings.

Air or gas supply should be clean and free of moisture for best results. While some pressure fluctuation is permissible, it is more desirable to supply air or gas to the pump at a constant pressure. This insures a more uniform flow into the regulating valve.

You can get topnotch output from air- or gas-operated pumps by installing and operating them correctly. Use the builder's recommendations and the tips in this article, and you're certain to have better results with your units.

Plant

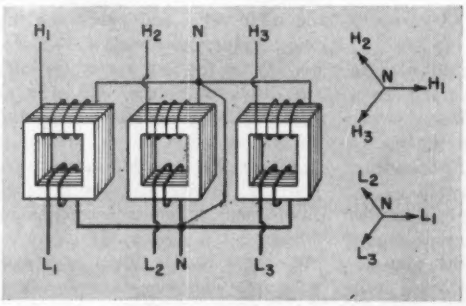
Electrical Fact File

No. 5: THREE-PHASE TRANSFORMERS

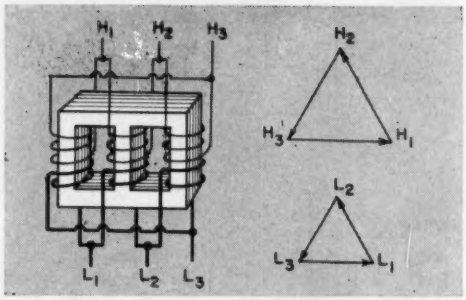
7 three-phase transformer connections

By NORMAN PEACH, *Assistant Editor*

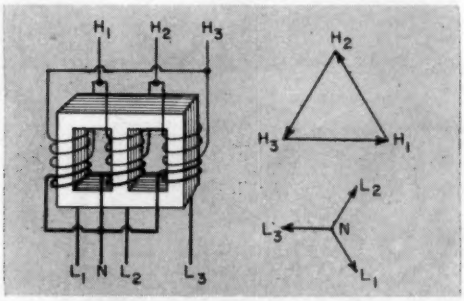
► Many 3-phase connections are possible both for single-phase units connected in banks and for 3-phase transformers. The more familiar connections are given here. A knowledge of polarity, ratio and impedance is important before connecting transformers into 3-phase banks. Transformers must be connected with same polarity for each. Same transformation ratios and impedances are also necessary if voltage and current of phases are to be kept balanced. Simple tests determine polarity, ratio and impedance, although the latter requires variable voltage.



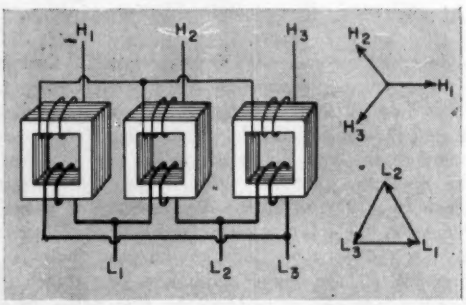
1 **Y-Y WITH CONNECTED NEUTRALS** has advantage that windings are subjected to line voltage ÷ 1.73. Y-Y connection without connected neutrals is rarely used since high, unequal voltages may result from unbalanced load, and high voltage and distorted wave from suppressed 3rd harmonic component.



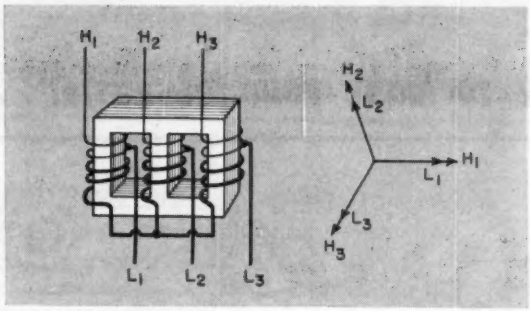
2 **Δ-Δ CONNECTION** has full-line voltage on windings, but current in each phase is line current ÷ 1.73. Delta-delta is thus suited to moderate voltage, large current operation. Ratio and impedance of transformers must be same to prevent circulating current and keep phase currents equal. Trouble will not result from 3rd harmonics since 3rd harmonic current can flow in deltas of either winding.



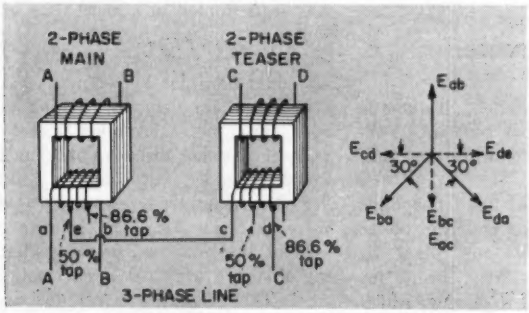
3 **Δ-Y IS USED** to step up voltage for transmission since Δ-Y ratio is 1:1.73. Also commonly used to step down to utilization voltage with 4-wire system: secondary 208 line-to-line, 120 line-to-neutral, or 480/277. Third harmonic does not cause trouble, and with secondary neutral connected to load neutral there'll be little unbalanced load difficulty. Δ-Y banks can't be paralleled with Δ-Δ.



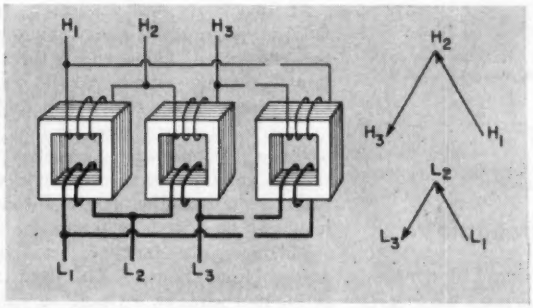
4 **Y-Δ IS PRACTICALLY REVERSE** of Δ-Y. Used mainly for stepping down from transmission voltage. Third harmonics are taken care of by secondary delta, or by connecting primary neutral to power-source neutral. Delta-connected secondaries can, in emergencies, be operated with two transformers.



5 **AUTOTRANSFORMERS** have one winding; secondary voltage is obtained from taps. Ratio is total number of turns to number of turns carrying *difference* between secondary and primary currents (lower part of winding, sketch). Autotransformers can also be used for voltage stepup. Where ratio is low, as in reduced-voltage motor starting, autotransformers are lighter weight than others, but can't be used where secondary must be insulated.

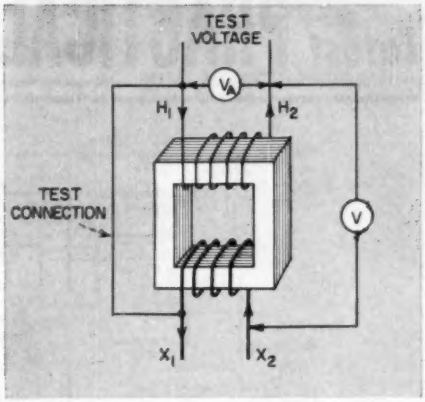


6 **PHASE CONVERSION,** 3- to 2-phase, is accomplished by T (Scott) connection. Phase *A-B* of 2-phase side is induced by 3-phase winding *a-b*. Voltage in *C-D* is induced by vector sum of 3-phase voltages *b-d* and *d-a*. Same connection converts 2-phase to 3-phase. If needed, 50% tap on teaser may be used for neutral of 4-wire system. For 1:1 ratio autotransformer is generally used; for big voltage step, insulated types.

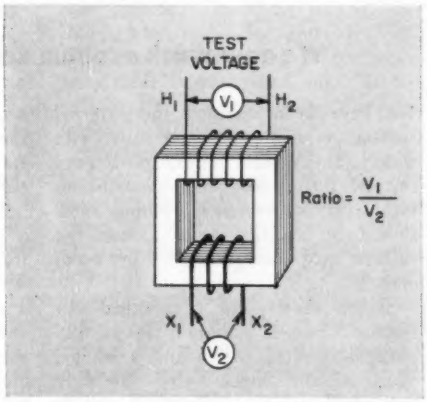


7 **OPEN-Δ** connection may be used in emergency and gives approximately balanced secondary voltage, but bank capacity is only 58% of 3-transformer bank. Each winding must now carry full-line current rather than line current ÷ 1.73; power factor is also reduced. Two single-phase autotransformers may be connected open Δ.

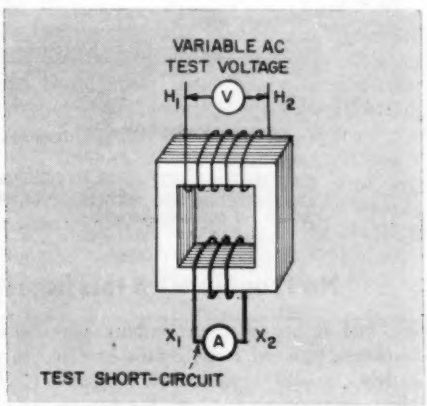
Three transformer tests



POLARITY TEST. When V_T is less than V_A polarity is *subtractive* and leads are marked as shown. When V_T is more than V_A polarity is *additive* and secondary leads are reversed.

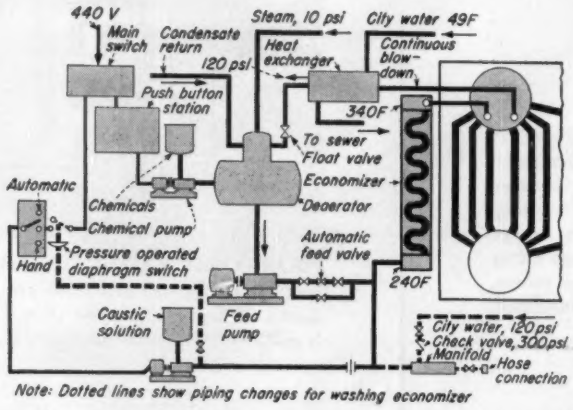


RATIO TEST. Transformer ratio equals primary voltage divided by secondary voltage. Applied voltage and instrument range should permit accurate readings of V_1 and V_2.



IMPEDANCE TEST. Adjust primary voltage until shorted secondary carries rated current. Transformer impedance is equal to *applied test voltage* divided by short-circuit current.

Latest PRACTICAL IDEAS to make your job easier . . .



We now wash economizer tubes with water

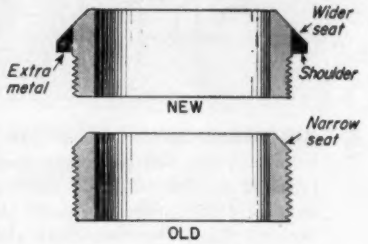
We have been washing the external surfaces of our economizer tubes with water. This annual routine gives good results. But as most fuels contain sulfur in varying amounts, washing water should be alkaline to neutralize the sulfuric acid that gathers on the economizers.

Sketch shows how I arranged our system. Changes include a 300-psi diaphragm-operated switch and a 300-psi ½-in. all-iron check valve—the only two additional parts needed.

To use, valve to feed line is closed, valves to washing manifold and pressure-switch valve are opened. Relay has a 2-position switch, automatic through a timer, and is constant. Constant position is used with the pressure switch.

In chemical tank we use ten pounds of caustic soda and one pound of boiler treatment, which in our plant is Wright's *Pyrofosforg*. After hosing for a short time, we took a sample, which showed a pH of 11.3. When the hosing valve is closed, the iron check valve closes, and chemical pump brings the pressure up to 300 psi. This operates the switch and stops the pump.

G C Lewis *North Burnaby, B.C.*



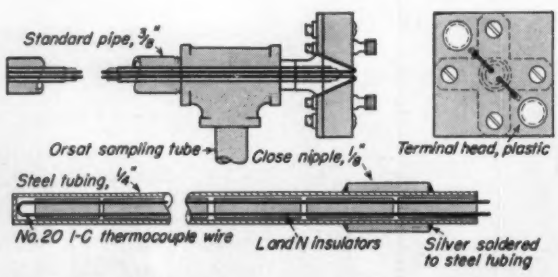
New seats save old valves

Our Y-type blowoff valves gave us so much trouble because of leaking seats that I was going to order new ones. Boiler pressure is 160 psi. Trouble was seats eroded in a short time, causing them to leak. Sketches show that old seat was very narrow, didn't hold up under constant blow-down.

I solved problem by making seats with more metal. Another feature of new seats is that threads don't run into the seat proper, but come to a shoulder. This shoulder screws down against valve casting. Also, the bearing surface of the new seat is twice that of the old one. Material is cast stainless steel. These features have reduced seat maintenance greatly.

H B H Maundrell *Haney, B.C.*

Ed. note: Maybe I'm sticking my neck out, but I bet a good cigar the seats that caused trouble were homemade by a predecessor. The design doesn't look like it came with the valve.—*Steve*



No trouble with this homemade thermocouple

We find it handy when running performance tests on large central-station boilers to use combination gas-sampling, thermocouple tubes. We experimented with glass-covered duplex thermocouple wire on inside of ordinary gas-sampling tubes. But after a while the insulation deteriorated and shorts developed, giving bad temperature readings.

This led to designing the tube in sketch. It can be built from standard parts and materials. While our tubes are about five feet long, only limit to length is excessive droop. Outer tube is ⅜-in. standard pipe, open at boiler end. It has ⅜-in. tee at inner end. Gas sample passes to orsat through side branch of tee.

Thermocouple well is made from 0.035-in. wall, ¼-in. steel tubing with one end sealed. Other end is threaded into ⅛x⅜-in. crow's-foot with ⅛-in. close nipple, silver soldered to tubing.

Crow's-foot, when screwed into end of ⅜-in. tee, provides a positive gas seal at point where thermocouple well enters sampling tube. It also furnishes mounting lugs for fiber terminal block.

Thermocouple junction was butt-welded from 20-gage bare iron and constantan wires on a *Do-All* saw-blade welder. Leeds and Northrup *Standard 723* insulators just fit inside the steel tubing. Length of last insulator was adjusted so the tip of couple was pushed against well's bottom.

R G Schuerger *Lakewood, Ohio.*

keep your plant in tiptop shape

STEVE ELONKA, *Associate Editor*

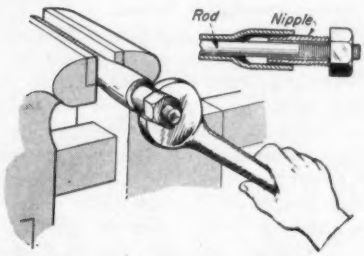
Plant-made pipe assembly speeds equipment checks

WE HAD THE TOUGH PROBLEM of removing a pressure-diaphragm assembly from a factory-assembled control system at our power plant. An all-thread nipple and an elbow were installed between the motor and potentiometer bank.

After working over two hours with a hacksaw to cut nipple and remove ell, we reinstalled it again with a plant-made pipe assembly. A close nipple was brazed to a coupling and then brazed to the long 10-in. nipple. A hex-headed nut was brazed near the end, out in the open, to turn the assembly.

Now it's simple to remove this special assembly and to clean and replace our pressure controller whenever needed.

L W FITZPATRICK
Jefferson City, Mo.



How to insert hose nipples quickly

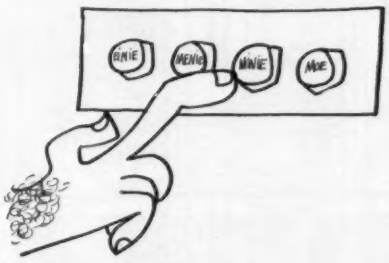
Inserting nipples in air hose can be a mighty tedious job. Easy way is to thread a long rod that's small enough to slip through the nipple, sketch. Insert the chamfered nipple, place threaded rod through nipple into hose, and grip hose in vise as shown. Now pull up on nut until nipple is forced into position. Caution: Don't make vise tighter than needed to keep rod from slipping. If you do, hose may be damaged when squeezed by vise.

H B MCDERMID
Long Beach, Calif.

Dear Steve:

Your *Plant Operators' Manual* is a lifesaver in training my 83-man crew in this new refinery. We issue a copy to the men along with other training material. Each man can keep the $5 book if he passes a simple test after three months on the job. So they study.

J MANSFIELD *Galveston, Texas*



What would you have done?

We took a marine power plant out of a scrapped ship and erected part of it ashore to drive a large multistage centrifugal blower on a wind-tunnel job. We changed boiler from mechanical atomization of oil to steam atomization, to speed operations because of highly variable loads—up to 15,000 hp, then a drop to almost no power, up to 8000 hp for next run, etc.

Operating policy upon shutting down was to cut off oil first, leaving the steam to blow nozzles clear of oil before cutting off steam. Forced-draft blowers were cut off last to purge boilers of all unspent vapors. This was an express-type boiler with controlled superheat.

Weeks later a few boiler tubes failed, in spite of boiler having been completely retubed. After cutting out burned tubes, we found signs of oil. But our regular feedwater tests had failed to show any oil in feed. We examined heaters, even possible leakage of lube oil along turbine shaft into turbine. No signs of oil. We dumped our entire feedwater, replaced bad tubes and lighted off. A few weeks later more tubes burned out. Oil was still getting into feedwater, and we weren't a bit happy.

Finally, burners proved to be the culprit. By shutting off the oil first and then the atomizing steam, condensation of steam in line caused vacuum to draw some residual oil into the steam line. Then this oil crept back into the auxiliary steam line and got into the main feed, settling in the generating tubes. Trouble was cured by changing our timing: We shut off the steam at burners first, then the oil. That also avoided oil drip into the furnace. What would *you* have done?

H M NEHAUS *Philadelphia, Pa.*

Here's what I would have done

For B H Coker, Feb, 1956, p 131, check of boiler feed pump's suction and discharge pressure gages would show if pump and piping system were OK. He says the check valve on the discharge side of pump leaked, allowing hot water from boiler to act against the pump. Since this water pressure is nearly equal to boiler pressure, pressure gage on discharge side of boiler feed pump would read accordingly, indicating leakage across the check valve when pump was not operating. This same pressure would act upon the pump's suction pressure gage. A comparison of these values with normal readings when pump was delivering feedwater would quickly indicate the troubles related by Coker. Pressure gages installed on suction and discharge sides of any pump provide a quick, convenient means for checking pump performance at a glance.

H B WAYNE *Brooklyn, N. Y.*

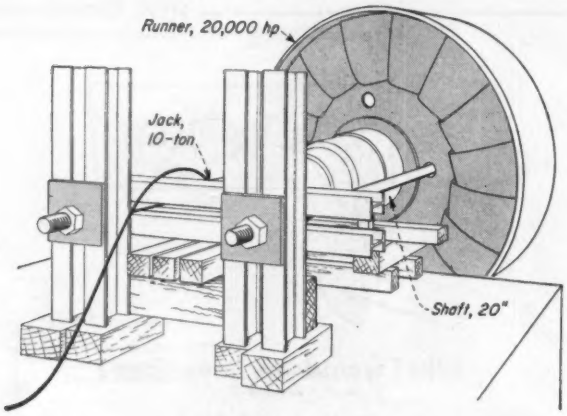
Did you know . . .

that ground resistance on lightning rods and arresters needs occasional testing to make sure it's not excessive? If resistance exceeds 5 ohms, the ground affords questionable protection. A good time to test grounds and improve them if needed is when the lightning season is approaching. *Courtesy of the Factory Mutual Record*

Turn page for more ideas

More PRACTICAL IDEAS

Begins on page 132



Here's your 'trick' of the month

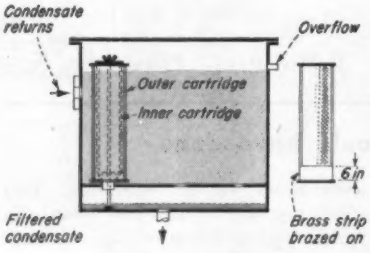
A hollow 20-in.-diameter shaft on a 20,000-hp horizontal turbine failed from fatigue. In trying to remove the runner from the shaft, all the orthodox methods, such as 4-in. pull-rods, a 100-ton jack, and heat applied to hub, failed to budge the runner.

Since the shaft was hollow, one of our Marmaduke Surfaceblows suggested packing dry ice inside the shaft at the hub location, which we did. At the same time we took strain on the pull-rods and jack, then sat back and waited.

In about three hours there was a heave and recoil like the blast from a big 16-in. naval gun. The runner parted company with the shaft, with which it had been in contact for 40 years. The jack and dry ice did the work. All we did for three hours was wait—and keep on drinking coffee.

L McWilliams

Shawinigan Falls, P.Q.



Gravity filter OK now

Our buildings are heated with exhaust steam from reciprocating engines. Gravity filters for removing oil from condensate returns didn't do a good job. It let oil into our boilers. Here's how we licked the problem:

Filter unit is a tank with a double bottom, sketch. It has a number of rectangular brass wire-mesh cartridges, one inside the other. These cartridges are covered with a filter medium of terry toweling. But as toweling becomes clogged with deposited oil, the water level inside the tank rises until it reaches the overflow outlet. That shows that the toweling has to be changed.

Problem was that water wouldn't overflow from filter tank because toweling shrank when it got wet. Then an opening of about ½ in. was left under the filter cloth. This opening allowed oil to pass through filter to boilers.

We solved problem by welding a 6-in. brass strip to bottom of all filter cartridges. Now toweling can shrink and still prevent oil or water from passing under filter cloths. It also gives us a 6-in. water level before filtering begins, causing oil to float on water's surface. This alteration reduced our filter capacity slightly, but brought its efficiency to a high level.

R Morrow

MacDonald College, P.Q.

Did you know . . .

that freshly mined coal absorbs oxygen more rapidly than coal that has been out of the mine some time? So freshly mined coal is more liable to heat spontaneously, and thus cause fires.

Check ac and dc controls

When inspecting your rotating electrical equipment, remember that their control equipment is just as important. Here are common sources of trouble:

1. Loose connections develop excessive heating and may cause burnout. Loose connections to resistor or resistance banks in wound-rotor motors lead to phase unbalance or single-phase operation. Loose connections at thermal relay terminals can result in overheating, change in calibration and possible pre-operation.

2. Dirty or rusty operating parts. Most breaker mechanisms have a series of fulcrums, latches, latch arms and spring assemblies. Any additional friction, in the form of dirt, grime or rust that collects on these parts causes delays or failure when most needed. This often results in costly damage to controlled equipment and cables.

3. Pitted contacts become dangerous when they have less than two-thirds of their original thickness or when they become excessively burned.

4. Moisture or acid fumes. Moisture in control cabinets or on panels can cause false starts or cutouts when holding coils. Undervoltage release coils or contactor coils become grounded through moisture or through corrosion from acids. Check all operating coils and contactors regularly, and remove for varnish sealing when needed.

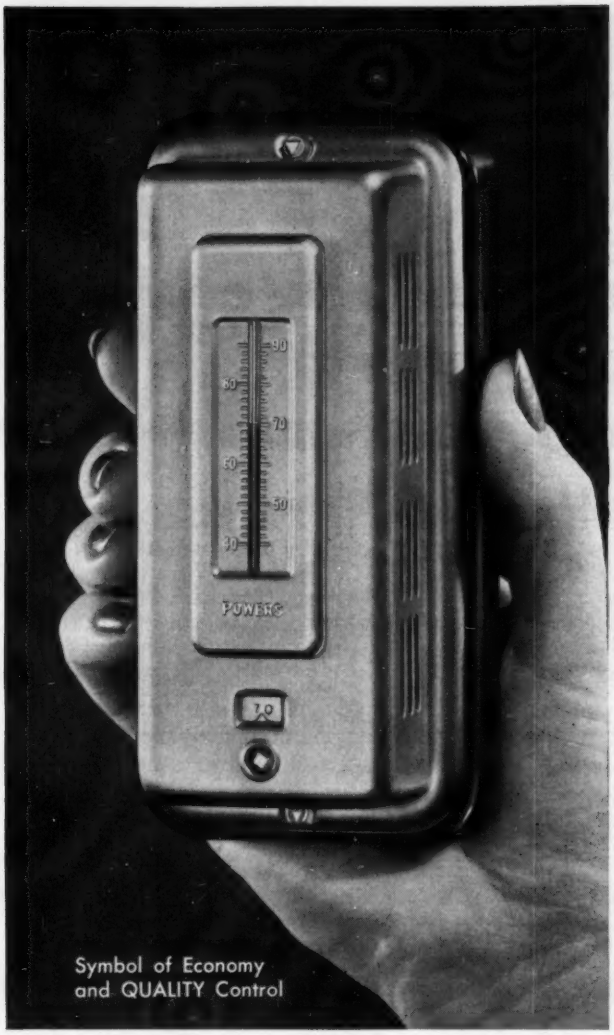
5. Contact pressure. Slack contact springs cause excessive heating by reducing the effective contact area and permit continued arcing to a point of destruction. Replace springs when they are slack, become damaged or lose tension.

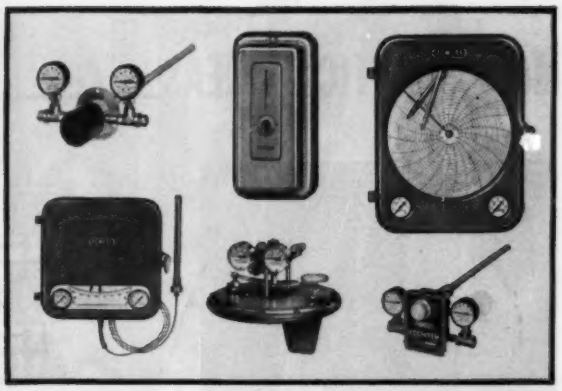
6. Frayed shunts. On dc brush rigging or on control contactors, frayed shunts can cause serious trouble if permitted to go to ground. Replace frayed shunt at once, secure the shunt ends in their lug connectors.

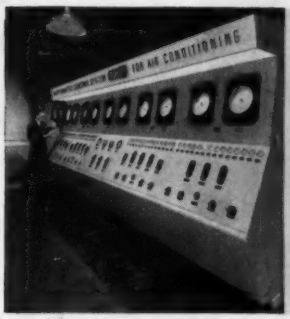
7. Dash pot and plunger relays should be hand operated periodically to insure that the solenoid is not jammed or sealed in the dashpot damper oil. Many trip plungers have not operated for extended periods and become jammed from rust or paint flakes. Or trouble may be dashpot oil has congealed to tar consistency. Renew oil in dashpots when needed. Replace bellows in older-type relays if the leather or rubber has deteriorated.

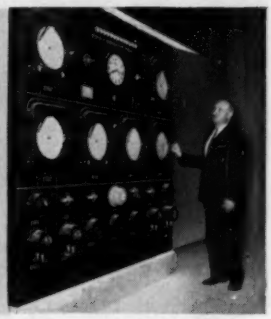
—Courtesy, Mutual Boiler and Machinery Insurance Co, Waltham, Mass.

Turn page for more ideas









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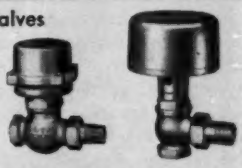
Give more accurate control
Eliminate packing maintenance
Prevent leakage of steam and water



POWERSTROKE Piston Operators for Dampers, etc.
Sizes Available: 3", 4", 6".

POWERS Control Systems eliminate OVER-heated rooms, reduce fuel bills and increase production

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The superior year after year performance of Powers QUALITY control has been time tested and proved dependable in thousands of buildings since 1891.

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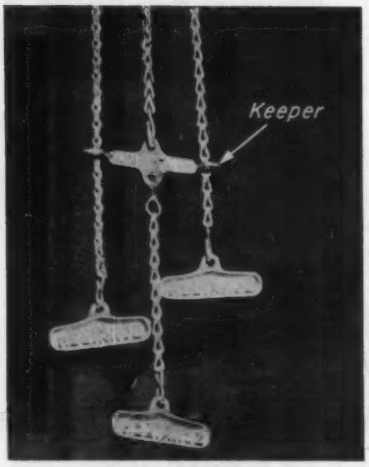
65 Years of Automatic Temperature and Humidity Control

(c77)

More PRACTICAL IDEAS

Begins on page 132



No more tangled chains

Pull chains on water column trycocks can be a nuisance, especially if boiler is high and chains are long. They swing around each other and become tangled. To solve the problem, I made the keeper, photo, to keep chains spaced apart. It's fastened to center chain, keeps outside chains at set distances. Mine are cast of aluminum as we placed them on several boilers. Now, chains are not tangled when they operate.

J W Blake *New York, N. Y.*

Don't use outlet dampers on i-d fans

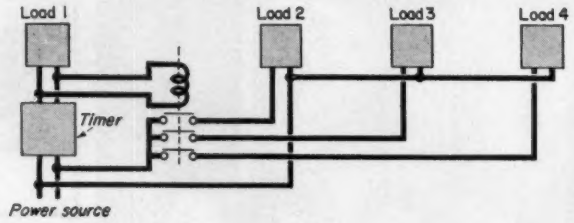
Outlet dampers with necessary damper stops occupy a large percentage of the outlet area and cause eddy currents in gas flow. This is so even when damper is placed at right angles to the fan shaft. Because of space taken, these dampers seriously interfere with velocity pressure recovery.

In the closed or partly closed position, outlet dampers cause gas pressure in the fan housings. Gas thus leaks through bolt holes and bolted flanges, around damper shafts, etc. It is almost impossible to prevent or eliminate this leakage.

When outlet dampers are partly closed, gas is whirled around in the fan housing. If abrasive dusts are present, this action causes increased wheel and housing wear.

My experience shows it's best not to use outlet dampers for control purposes on induced-draft fans. They may be OK for isolated cases, but don't overlook their adverse effects.

L V Andrews *Worcester, Mass.*

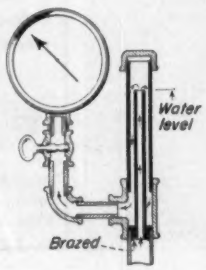


Now, one timer does double duty

Contacts of a motor-driven timer, used as a flasher, became overloaded as we added lamps. So several new lights were needed in widely separated spots in adjacent buildings.

I took a small 3-phase magnetic switch, mounted it in horizontal, sketch. Then I disconnected the closing coil from the regular circuit, used each pair of contacts for different circuits. That took care of several times as many lights, with only one timer. This hookup worked beautifully for five years with no maintenance. It may still be working for all I know.

C G Howaiter *Canton, Ill.*



Steam gage's water seal...

can be made of piping where vibration is bad or copper coils won't hold up. Sketch shows exactly how I solved this problem with standard pipe fittings. Water seal can be as high as needed to protect Bourdon tube from heat by using a longer ⅛-in. pipe. I've made several of these water seals to solve specific problems. They work very well.

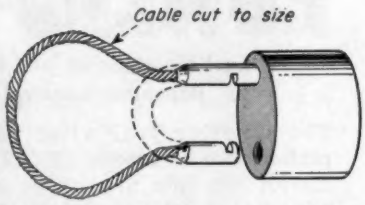
S A Autio *Orange, Mass.*

Today, oil is hot

Heating coils in our underground fuel-storage tanks froze because they were filled with water. Coils cracked and let water into the fuel, giving us more trouble. Last summer I cleaned these tanks and fixed up the coils. To make sure they won't freeze again, I filled coils with No. 2 fuel, which we carry in some tanks.

We had a small heat exchanger, which we hooked up between the hot-water piping in the plant and the coil piping. Heating coil piping had a separate circulating pump anyway, so this circulates oil through the already-hot exchanger and into tanks. This keeps our high pour-point fuel warm. There's no danger from water. We don't have to run circulating pump all the time, so we have a small expansion tank in system to handle temperature.

D L Cochrane *Cambridge, Minn.*



Lock stretcher

We modified an ordinary padlock so it can be used to lock any size disconnect switch. Company rule is electrician or maintenance man must lock the power source when working on a machine.

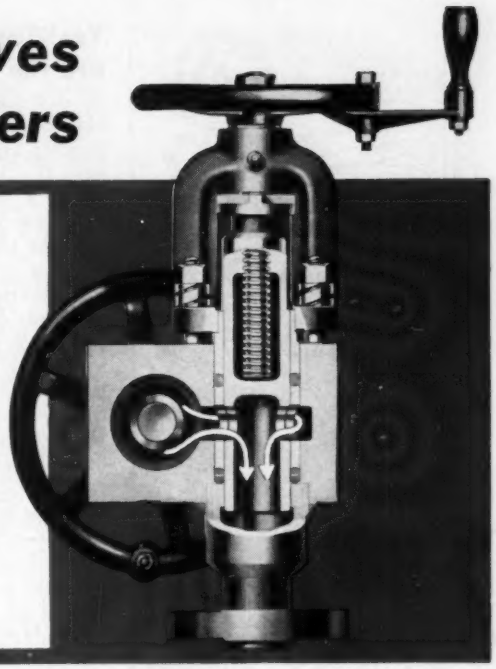
H T Bailey *Brillon, Wis.*

My biggest boner . . .

Please turn to page 188

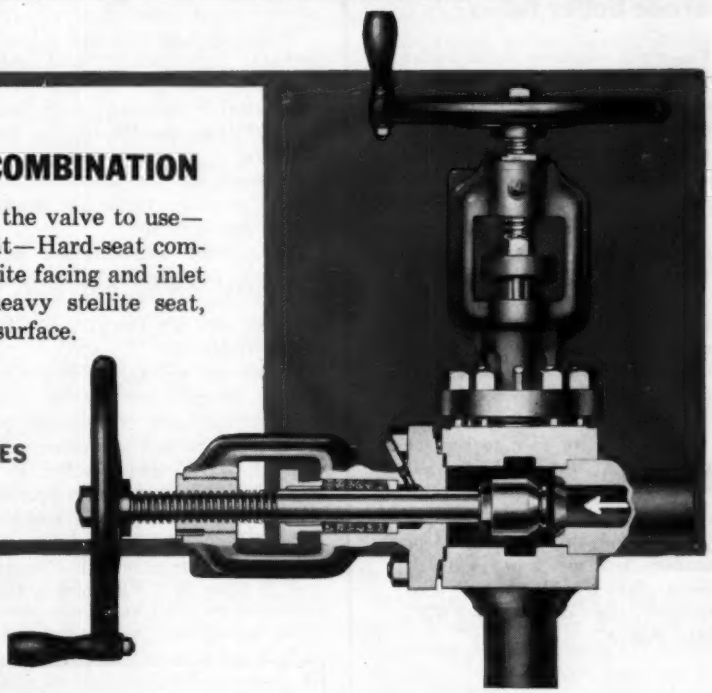
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

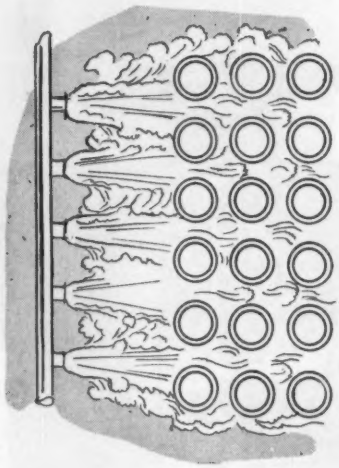
OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES

Write for Yarway Catalog B-434

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY BLOW-OFF VALVES

Have a PLANT PROBLEM? Tap the



The question

Why does soot blowing erode boiler tubes?

I'm chief engineer in a boiler plant that's equipped with three relatively new 25,000-lb-per-hr coal-fired boilers. Operating pressure on these units is 250 psig. Coal is burned on spreader stokers.

Recently, during one of our regularly planned boiler inspections, we noticed that the walls of boiler tubes in the first gas pass had thinned out in several spots. We believe the steam-operated soot blowers that clean these tubes have something to do with the erosion condition.

Naturally, we plan to replace these tubes. But we don't want to face the same problem all over again. We'd like to get at the root of our difficulty. Can readers tell me how to track down the trouble? Are soot blowers the culprit? — *WGW*, May, *Power*

The answers

Yes! Soot blowers are the culprits

Three facts lead me to believe that soot blowers are the cause of *WGW's* trouble: (1) The boilers are relatively new. (2) Since trouble was discovered during a planned shutdown, only one boiler was involved. (3) Tube thinning is in the vicinity of soot blowers.

Steam erosion of valve-in-head-type soot blowers is usually caused by misalignment of the nozzle openings in the soot-blower element in relation to the boiler-tube spacing. Soot-blower-element nozzle centers should be set in the cold condition to allow for expansion when heated. In the hot position, center of the blow (a line bisecting the blower arc) should not cross any of the boiler tubes. As boiler-tube spacing decreases, the misalignment problem increases.

Initial alignment was probably perfect, but a blower element may have warped in operation. Center of the steam blow could then strike tubes. Sometimes the first-pass tubes themselves become distorted.

If tube thin spots are of a local nature (as they probably are) and are accessible, they can be built up with weld metal in accordance with National Board "Rules for Repairs by Fusion Welding."

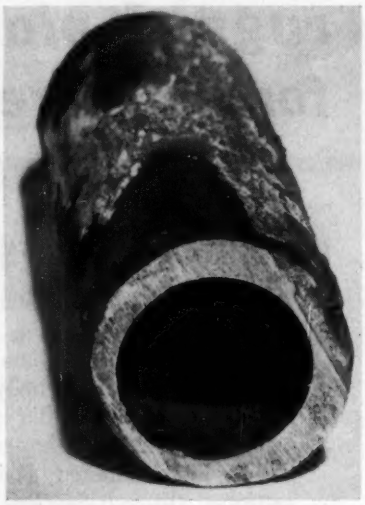
If tubes are not accessible and if they're worn to an unsafe condition, *WGW* should retube.

To prevent a recurrence of the trouble he can take the following steps: (1) Examine the soot-blower element to make sure it's straight. (2) Check nozzle alignment.

If elements are warped or some supporting hangers are broken, chances are the condition will recur. So it doesn't pay to just straighten out the element. *WGW* should select an element that's made of a more heat-resistant material. In replacing soot-blower elements, consider the advantages of installing retractable soot blowers.

E D Dow Jr *Barberton, Ohio*

Want help with a plant problem? Send in your design and operating headaches to us. We'll give readers a whack at them.



Trouble may be corrosion

WGW'S trouble may be fireside corrosion rather than erosion due to soot blowers. The corrosive condition is the result of vanadium, sodium and sulfur in the coal. These elements, in the form of vanadium pentoxide, sodium sulfate and sulfur oxides, attack the fire side of boiler tubes and cause metal wastage, see photo above.

To minimize the condition, wash and neutralize tubes and other surfaces with a lime slurry at least once a year. In addition, there are chemicals available that may be introduced into the flame to counteract the corrosive effects of these harmful compounds in the fuel.

R S Norris *Larchmont, N.Y.*

Take a good look at hangers, baffles

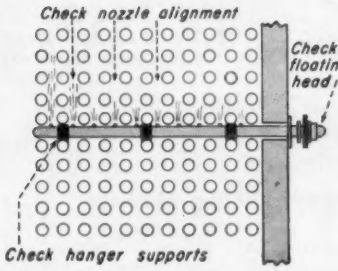
If soot blowers are the cause of thinning tubes I suggest that *WGW* check the blower hangers or supports to find out if they have broken loose. A loose or broken hanger allows steam to impinge on the tubes, wear them away.

I would also examine baffles to see if they have holes or cracks. A baffle crack permits the hot gas to short circuit. Result: Gas velocity increases. High-speed hot gas that contains flyash can easily erode boiler tubes.

R C Conk *Newark, N.J.*

know-how of over 45,000 Power readers

HOWARD KALLEN, *Associate Editor*



Is WGW burning coal of high ash content?

There's a good chance that *WGW* is burning coal of much higher ash content than the units are designed for. Boiler designers carefully consider the number of gas passes and gas velocity in relation to coal's ash content. As ash percentage goes up, number of gas passes is reduced. Resulting lower gas velocity cuts down flyash impingement on first-pass tubes.

Here are items to check:

1. Soot-blower nozzles should discharge into the gas stream without impinging on tubes, sketch above. If original alignment has shifted and the nozzles are discharging toward a tube, entrained flyash acts like a sand blast, erodes through the tube in a short time.

2. Wrong soot-blower element or hangers may have been installed. If so, high first-pass temperatures could burn hangers or warp the element, thus destroying alignment.

3. Blowing pressure in each element should be just high enough to clean its area. Generally, more blowing pressure is needed in forward passes and less in rear passes. Most blowing units have some form of throttling device to regulate pressure. By keeping the blowing pressure as low as is possible, any erosion will be minimized.

M LEMAN *Shelton, Wash.*

Avoid condensate slugs

WGW's trouble could be caused by slugs of condensate in the soot-blower steam. He should make sure soot-blower piping slopes toward the drain valve. Grinding a flat spot on the drain valve disk insures continuous drainage. Also, it's a good idea to turn steam on for 15 minutes before blowing the tubes, to properly heat up the lines.

A W MACFARLAND *Burlington, N.J.*

Check these five points

While it's possible that *WGW's* problem may be due to a blasting and cutting effect of the steam plus soot and flyash, the following seems more likely to me: (1) Coal may have a relatively high percentage of fines, more than 50% less than ¼ inch. (2) Coal may have a high percentage of ash, more than 10%. (3) Peak capacity operation for extended periods may result in furnace-gas velocities that are too high. (4) Flyash reinjection may be causing trouble. (5) Furnace turbulence, resulting from two or more of the first four items listed, may be excessive. This would speed erosion.

Flyash and semi-coke, along with pyrites, stone shale and the various solid impurities that make up the free ash of raw coal are all very abrasive. *WGW* can improve conditions by (1) using a coal of coarser consist—with fines less than 35% under ¼ inch (2) using a washed coal with an ash content less than 6% (3) reinjecting only about 25 to 40% of the trapped flyash. He can return flyash to the furnace by blending it with the incoming coal at the stoker hopper. Readmitting flyash at the feeders reduces furnace turbulence substantially.

U B YEAGER, *Fuel Engineer*
Huntington, W. Va.

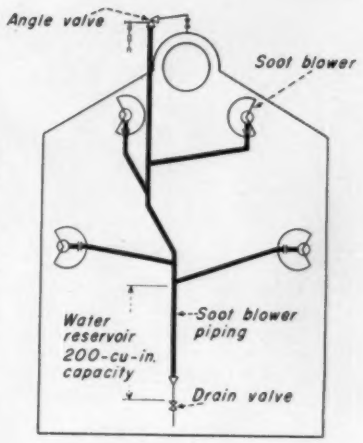
We had the same trouble

Our boiler plant is relatively new, consisting of two 8000-lb-per-hr coal-fired boilers. About one year after they went in operation a leaky tube was discovered. Inspection showed it was eroded. Check of other tubes revealed they were worn thin on one side.

Studying installation we found that soot blowers weren't installed right. Steam coming through nozzles was blowing on the tubes. After the element was lined up our troubles were over.

About four years later we developed another leaky tube. Soot-blower alignment was OK, but nozzle in the element opposite the tube failure had worn until it was out of round. Result: Steam was blowing directly on tubes. The element was replaced. We've experienced no further trouble due to tube wear.

H H ERDMAN, JR *Merrill, Wis.*



Drainage is important for soot-blower piping

When installing soot-blower piping special care should be given to right pitch of piping and elimination of water pockets. This prevents water from being carried into the soot-blower element and boiler tubes.

Steam supply to the blowers should come directly from the boiler to provide the driest steam possible.

H B SWYGERT JR *Greenville, S.C.*

Danger spots can be shielded

WGW's thinned tubes are result of flyash blasting by steam from soot blowers. Here are two steps we've taken to avoid this problem:

1. Half-round shields, of 1/16th-in. mild steel, 18 in. long, were placed over danger spots. Shields were held in place by two ⅛-in. mild steel straps, one inch wide. Straps pass completely around the tube with ends formed and drilled for bolts. Bolt head was tack-welded to under side of strap. After tightening, straps were tack-welded to the shield.

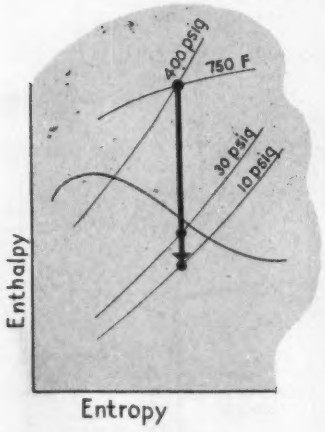
2. Orifices were installed in the steam line at each soot-blower flange to reduce blowing pressure from 175 to 100 psig. The lower pressure does just as good a job. But we pick up more flyash in our reinjection hoppers.

L B MCINTIRE *Rock Island, Ill.*

Turn page for info on estimating changed steam conditions

More PLANT PROBLEMS

Begins on page 138



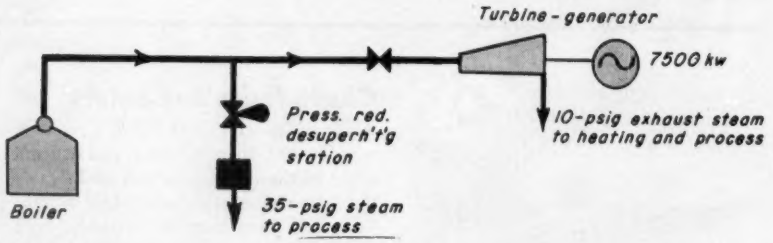
The question

How can we estimate effect of changed steam conditions?

Our industrial power plant installed a 7500-kw turbine about five years ago. Original steam conditions for this machine were 400 psig, 750 F at the throttle and 10-psig backpressure. Exhaust steam is used for heating and process.

Change in our process now requires 30-psig steam. Naturally we can't expect to carry the original electrical load on our turbine-generator. But we would like to know the effect of this planned change. Can we handle process needs in a more economical way? Will we run into trouble on our turbine operation? We'd like to get ideas from readers.—CSK, May, *Power*

The answers



Install a reducing-desuperheating station

Assuming overall efficiency is 65%, estimated steam rate at 10-psig backpressure is 21.0 lb per kwhr. Throttle flow at full load (7500 kw) is about 158,000 lb per hr. Boosting backpressure to 30 psig increases steam rate to 26.8 lb per kwhr, throttle flow to 200,000 lb per hr.

Lower specific volume of the exhaust steam at 30 psig reduces leaving losses. But this slight gain does not have appreciable effect on turbine performance.

Since throttle flow is limited by dimensions of the valve chest and turbine steam path, generating capability at 30-psig backpressure drops off about 22%, or 1600 kw. If the plant can't tolerate this available-power reduction, it may be possible to install other facilities to supply 30-psig steam. One arrangement employs a pressure-reducing desuperheating station connected to the main steam line, sketch above.

H B Wayne *Brooklyn, N.Y.*

How to figure power reduction

Turbine output varies inversely as the TSR (theoretical steam rate). TSR is found by dividing 3413 by the Btu's removed from a pound of steam when it expands ideally (a vertical expansion line on the Mollier steam chart) from throttle pressure to exhaust pressure.

After getting Btu's removed per pound of steam for existing and new backpressures (from a Mollier chart or set of steam tables), TSR's are figured.

TSR at 10 psig backpressure = 12.8 lb per kwhr

TSR at 30 psig backpressure = 15.3 lb per kwhr

At the same steam flow, power reduction is:

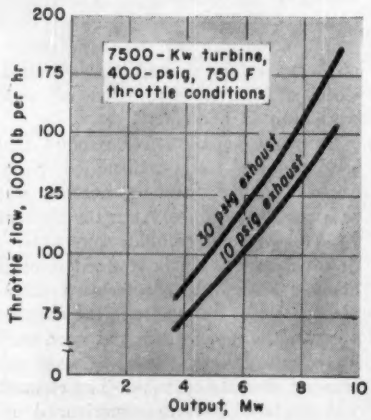
7500 kw(12.8 ÷ 15.3) = 6280 kw

The turbine is designed to carry about 20% overload with increased steam flow. Maximum output is:

6280 kw × 1.2 = 7500 kw

CSK will be able to carry a maximum of 7500 kw, but he'll have 20% more process steam available at the higher backpressure he specifies.

R J Martin *Elizabethton, Tenn.*



Retain an outside consulting engineer

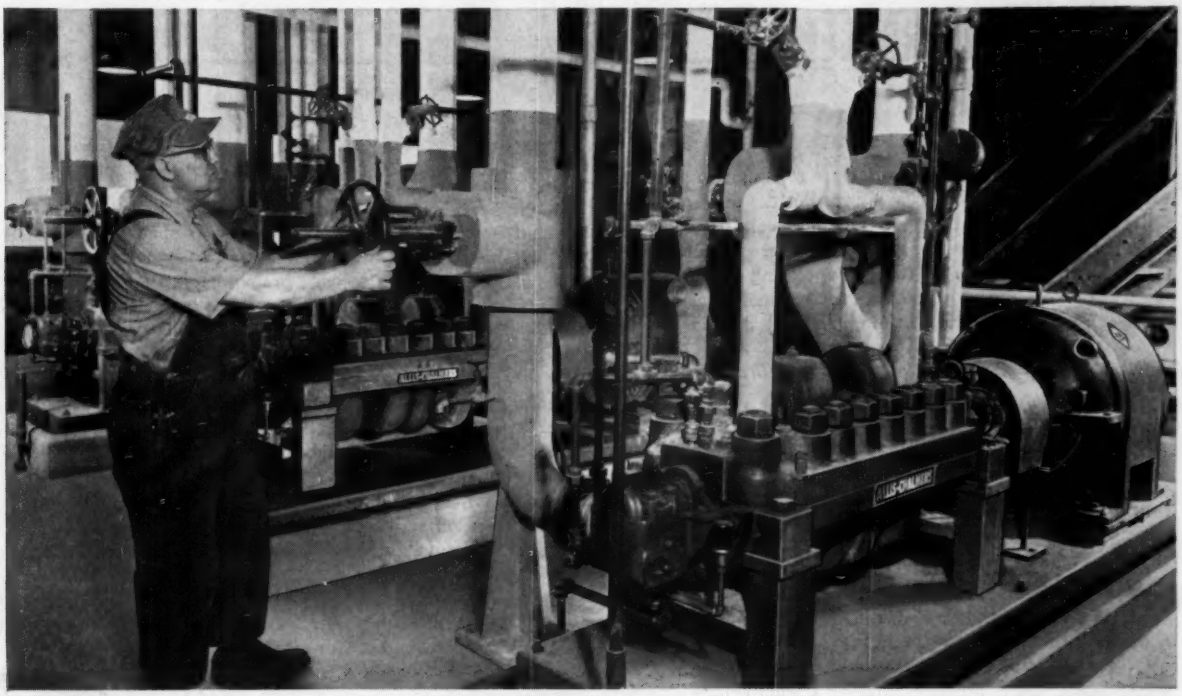
A competent consulting engineer should be retained by *CSK* to get the following types of info: (1) Predict turbine performance under different conditions. (2) Prepare condition curves such as the one shown at left for *CSK's* turbine. (3) Determine the feasibility of cutting a hole in the turbine casing to get cheap 30-psig steam without sacrificing too much electrical capacity. (4) Advise on other methods.

And, most important, he'll consider this plant as a special problem.

J Schneider *Needham, Mass.*

For more on changed steam conditions and new problems, turn page

Allis-Chalmers Pumps Meet Power Plant Requirements



New Pumps Give Milwaukee County Institutions

. . . Dependable Power Service

THESE modern multi-stage high pressure pumps assure continuous, economical steam for the Allis-Chalmers 3000-kw steam turbine units at the Milwaukee County Institutions.

As new members of the Allis-Chalmers complete line of pumps, these units are designed to meet medium-high pressure, continuous service requirements of boiler feed duty in lower volume ratings.

Horizontally split casing with suction and discharge in lower half provide for simplified maintenance—without disturbing piping. Both radial and axial balance maintains close clearances and fits, gives low thrust bearing loads. Bearings are double-row ball bearings or alternate sleeve bearing with Kingsbury thrust. Sleeve and Kingsbury combinations have ring oiling as well as pressure lubrication.

You get **MORE** than a Pump . . . When You Specify Allis-Chalmers

You can take advantage of Allis-Chalmers wide experience in supplying pumps to all industries. You are assured of modern design, heavy duty construction and correct application aid — all adding up to years of dependable service.

Allis-Chalmers is the only company that can offer you "One-Source" responsibility, with a complete unit — pump, motor and control — all built to work together. For "MORE" information about Allis-Chalmers pumps, call your local A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-5098

More PLANT PROBLEMS

Begins on page 138

Install exhaust-pressure regulator

CSK should install an exhaust-pressure regulator to give him process steam at the needed pressure. But the unit's generating capacity will be reduced. The loss can be made up through purchased power or through another generator.

He should run into no turbine operating difficulties. It may, however, be more economical to continue using turbine exhaust steam for 10-psig heating and get 30-psig process steam through reducing valves.

L E POLIKOFF *Brooklyn, N.Y.*

CSK may have to remove some blading

Changing the exhaust pressure of a backpressure machine just a few pounds has little effect on operating performance. But in *CSK's* case a 200% increase in exhaust pressure will affect the unit's economical operation and load capacity.

With most backpressure turbines, exhaust pressure is a factor in controlling speed as well as capacity.

It may be necessary for *CSK* to have a few rows of the last stages of spindle blades removed.

I suggest that he continue to operate the turbine at existing steam conditions. A pressure-reducing station can handle the 30-psig steam demand needed by the process.

R C CONK *Newark, N.J.*

Don't raise turbine backpressure. Use extraction steam

Assuming full-load operation and an overall turbine-generator efficiency of 75%, design throttle flow is about 126,000 lb per hr. This flow supplies 150 million Btu per hr for process and heating at 10-psig exhaust pressure.

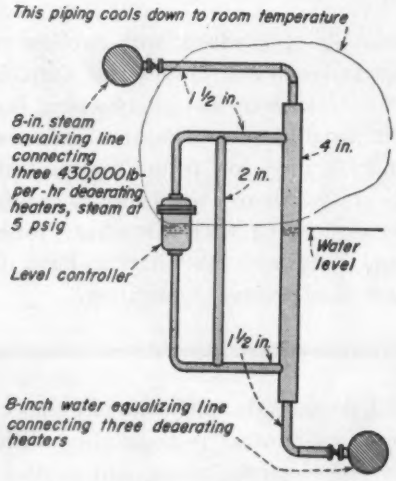
It certainly wouldn't be desirable to raise the turbine backpressure to 30 psig. But it shouldn't be difficult to extract 30-psig steam. If the turbine is impulse design, this pressure probably exists two stages from the exhaust. If it's reaction type, 30-psig is three or four stages from the exhaust. In any event, the turbine manufacturer can supply this info. *CSK* could then install a connection on the turbine casing at the right point.

Since the blading stages aren't spaced for bleeding, steam must be bled off at several points to get sufficient flow area. Using a minimum quantity of cooling steam and assuming that 12,000 lb per hr is enough to supply 10-psig heating-steam needs, 114,000 lb per hr is bled for process at 30 psig.

With the above conditions about 6300-kw electrical power is generated. 140 million Btu per hr is available for process and 14 million Btu per hr goes for heating. If *CSK* needs more heating steam and less process, he'll be able to generate more electrical power for his production processes.

J PAPAMARCOS *La Oroya, Peru*

YOUR AUGUST PROBLEMS


This piping cools down to room temperature
1½ in.
8-in. steam equalizing line connecting three 430,000-lb-per-hr deaerating heaters, steam at 5 psig
4 in.
2 in.
Water level
Level controller
1½ in.
8-inch water equalizing line connecting three deaerating heaters

1 Is our deaerator level control working right?

We have a level-control system on our deaerating heater that's hooked up as shown in the sketch above.

With all valves open and with 5-psig steam in the header, the 1½-inch steam piping cools down to room temperature. Dismantling the piping reveals that no pipes are plugged.

When returned to service, the entire system is hot. In about three days the piping has again cooled down to room temperature. The level control functions normally. How could this happen?—*JWG*

2 How should we set up emergency water supply?

We have a 160-bed hospital that uses about 30,000 gallons of water per day. But during an emergency we could probably get by on a lot less.

Watercooled auxiliaries, such as generators, air compressors, make continuous water flow vital. Our present source is an 8-inch city main, lime soda softened. All hot water is zeolite softened to zero hardness. We also have two electrically driven booster pumps but these couldn't be used during a power outage since they aren't on the emergency generators. They're intended for a future fifth floor and are now used only when city-water pressure is low.

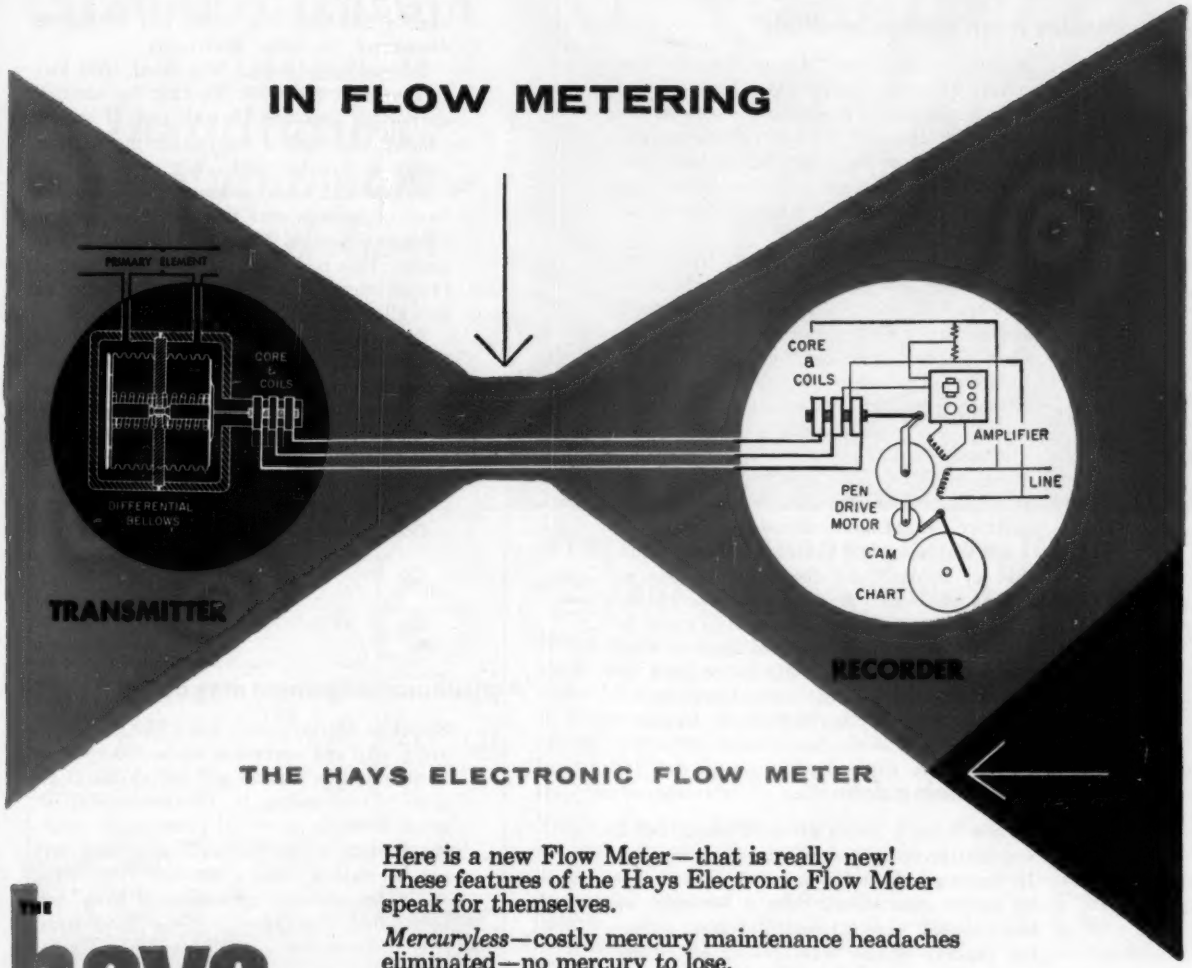
Ours is a limestone area and well water is hard. But emergency water could be valved into the existing 8-inch main in the boiler room, so hot water and boiler makeup could be softened before use, as it is now. I believe well water in sufficient capacity for emergency use could be reached at 100- to 125-foot depth.

What system is best for us? Deepwell with pump, elevated storage tank or reservoir? Whichever system is used, it must be automatic and independent of utility power, since the local utility might also be interrupted during an emergency.—*GRD*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches.

new dimensions

IN FLOW METERING



THE HAYS ELECTRONIC FLOW METER

THE **hays** CORPORATION
MICHIGAN CITY 3, INDIANA

Automatic Combustion Control • Veriflow Meters and Veritrol • Electronic Oxygen Recorders • CO_2 Recorders • Boiler Panels • Gas Analyzers • Combustion Test Sets • Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

Here is a new Flow Meter—that is really new! These features of the Hays Electronic Flow Meter speak for themselves.

Mercuryless—costly mercury maintenance headaches eliminated—no mercury to lose.

Rupture-proof Bellows—provide positive protection against over-range.

Continuous integration—motor-driven continuous mechanical integrator is extremely accurate even on rapid load changes.

Electronic operation—requires only 4 seconds for full scale pen travel with accuracy of ¼% of full scale differential.

Other features include null-balance transmission, powerful motor, easy readability, accuracy unaffected by normal temperature changes. Explosion proof transmitters and wide range meters also available.

For complete information, write for Bulletin 54-1074-222.

ARGUMENTS . . . *it pays to pop your safeties here*

ALTHEA THORNTON, *Assistant Editor*

Axing the generator: feat or defeat?

Marmy is not always infallible

Marmy's approach in "Marmy Axes the Generator" (POWER, June, p 148) shows he's not always infallible. For example, I assume the electrician changed the stator leads on outboard fouled-up generator. But if two stator leads are interchanged, generator would run backward as a motor. Which leads did he change?

I think this change would make the scheme fail on the first trial. Job would take more time than 32 minutes. A synchronous motor and generator both run in the same direction when supplied from the same power source. Running as a motor, the rotor lags slightly behind the rotating magnetic field; as a generator, rotor slightly leads rotating field.

Marmy was lucky if he could line up the ax marks without drilling new holes in coupling or making other changes. Seems clear the contractor could have collected his bet.

But any electrical contractor should know that by reconnecting the same winding so groups would start at same place where other generator groups started, same coils could be used. Of course, one could calculate at what angle the two rotors should be coupled together. But this wouldn't be so dramatic.

BRUCE BRYAN *Santa Barbara, Mexico*

I saw the job being done

Reader Bryan's points are well taken, but I *saw* Marmy do the job and can back him up. He knew all about lag and took care of this by simple calculations. Sure, a few holes of one coupling were rebored. But great suffering snakes! Marmy was blowing off steam. Angle of separation between ax marks is unimportant. They happened to stop 70 degrees apart. The important thing is Marmy won.

Chances of a reversal when interchanging two leads of a 3- or 2-phase machine are exactly fifty-fifty. But here's why he had to disconnect the units electrically.

Inboard generator *A* was rated 4000 kw; *B* generator, 3000 kw. To care for starting current, *A* was tied in with rest of station (45,000 kw) onto a low-voltage bus section, thence to transformer bank.

Bank's high side was connected to another bank of transformers that fed back to low-voltage section of bus connecting to *B* generator. This took some of the "ump" out of in-rush current. But why should Marmy go into all this?

Bryan is wrong in saying same result could be had from merely reconnecting faulty machine. Not in this case. Those old generators were closed-slot bar wound. Bars were longs, mediums and shorts. Coils were formed by connecting these bars with solid preformed jumpers so starting only one slot out threw out entire winding. So Marmy is right.

LLOYD MCWILLIAMS
Shawinigan Falls, Canada

'Agricultural' alignment may be OK

Sketch in Marmy's story looks like generators are geared and operate at about 900 rpm. So there would be 4 poles and 360 electrical degrees corresponding to 180 mechanical degrees. Error in electrical phase angle resulting from this "agricultural" alignment may not be serious. Also, I question if coupling could be reconnected without drilling new bolt holes. But anyway it's a good story.

G L OSCARSON *Minneapolis, Minn.*

Our hero did it the hard way

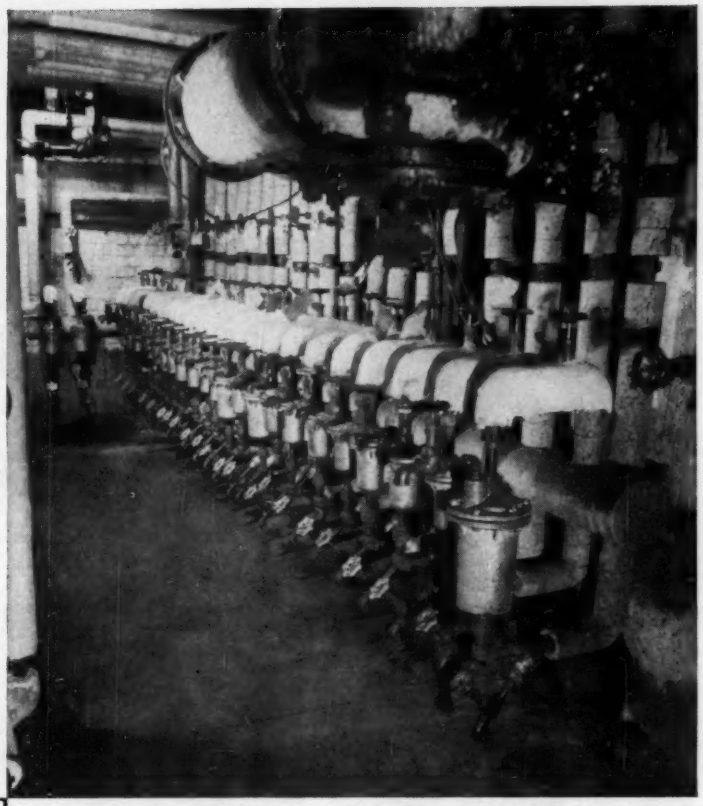
Marmy's general method was OK, but he made the job tougher by running the machines at full speed. His scheme would have worked equally well at any speed above 10 to 15% of full speed.

Marmy had the electrician change the leads. Usually this isn't necessary. He was lucky to be able to bolt the couplings together to line up his ax marks exactly. Many couplings haven't a fine enough adjustment for that. Then there might still be circulating current trouble.

Also, for lining up two synchronous machines, there's a differential type of gear coupling that gives you fine adjustment.

M R LORY *E Pittsburgh, Pa.*

How Steam Trap Standardization *reduces Installation and Maintenance Work and Cost*



No Bypasses Needed. Traps can be replaced in a couple of minutes by uncoupling the unions and installing a "spare" trap complete with proper length pipe connections and half unions.

ORIFICE SIZES	
PRESSURE	SIZE
0-40	7/32
40-60	5/32
60-150	4/32

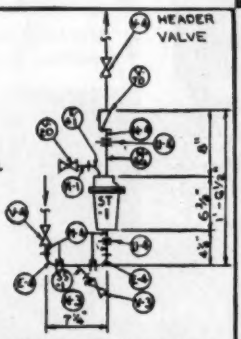
CAPACITY-0-300#/HR

NOTES:

DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.

IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.

TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.



BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP

MARK	REQD	MAT'L	DESCRIPTION
ST-1	1	SEMI-STL.	1/2" STEAM TRAP - ARMSTRONG #211
SS-1	1	CAST STL.	1/2" STRAINER - 250# W.S.P. - [redacted]
V-4	2	BRZ	1/2" GATE VALVE - SCRD - 200# W.S.P. [redacted]
V-20	1	BRZ	1/2" GLOBE VALVE - SCRD - 200# W.S.P. [redacted]
V-3	1	BRZ	1/2" GATE VALVE - SCRD - 200# W.S.P. - [redacted]
V-70	1	BRZ	1/2" CHECK VALVE - SCRD - 200# W.S.P. - [redacted]
E-4	2	MALL. CAST IRON	1/2" - 90° SCRD ELL - 2000#
E-41	1	MALL. CAST IRON	1/2" - 90° STREET ELL - 3000# - [redacted]
U-4	2	MALL. CAST IRON	1/2" UNION - 2000# - [redacted]
N-1	1	STL	1/2" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-3	1	STL.	1/2" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-4	6	STL.	1/2" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53
N-4/4	1	STL.	1/2" - 4" LG. NIPPLE - SCH. 80 - SEAMLESS ASTM A-53

Trap Maintenance Costs Reduced $25,000 per Year with Armstrongs

Major reductions in steam trap installation and maintenance work and cost can be achieved by standardization on one make of trap which, in turn, permits standardized hookups. A major chemical company reports an annual maintenance saving of $25,000 since installing 4000 Armstrong traps according to the drawing and photograph shown here. Additionally, trap parts inventory is reduced and purchasing is simplified.

Traps of a Size Interchangeable. Note that exact dimensions are given for the pipe fittings, including nipples connected to each size of trap. When a trap needs repair, the unions can be uncoupled, the trap lifted from the line, and a "spare" carrying identical pipe connections slipped in place. In as little as one or two minutes, a faulty trap is replaced. It is then repaired and takes its place as a "spare".

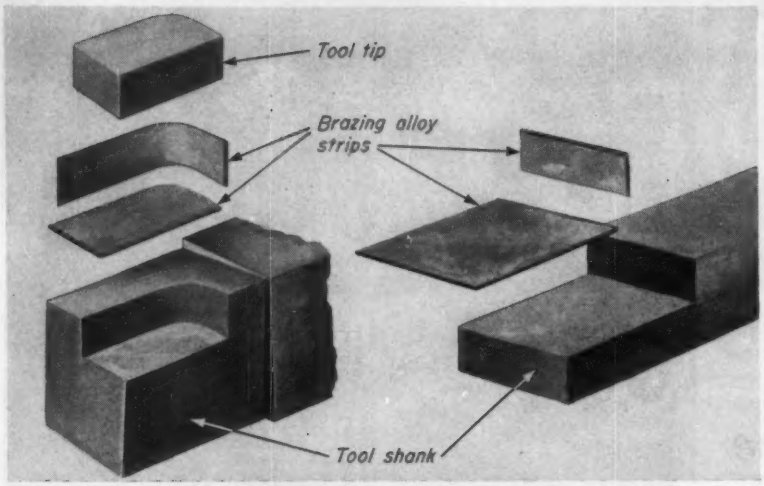
$25,000 Trap Maintenance Saving. Records on the Armstrong trap installation described here show that the cost of repair parts was approximately $10,000 less annually than with the traps previously used. Reduction in maintenance labor brings the total saving to $25,000, per year. *And, fuel savings attributable to the traps are at least equal to the maintenance saving.*

Standardized hookup includes test valve for trap testing, strainer, blowdown valve for cleaning trap, shut-off valves and unions for quick replacement.

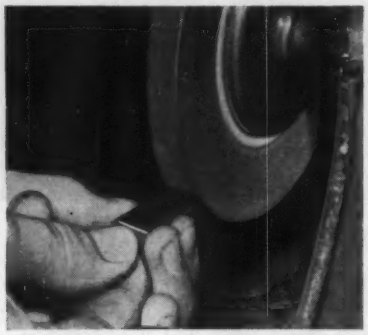
FOR COMPLETE INFORMATION on the traps that slash maintenance costs ask for the Armstrong Steam Trap Book containing complete data plus selection, installation and maintenance recommendations. Call your local Armstrong Representative or write.

ARMSTRONG MACHINE WORKS, 812 Maple Street • Three Rivers, Michigan

ARMSTRONG STEAM TRAPS



1 Cut and shape pieces of brazing alloy from a strip to fit the recess in tool shank as shown. Be sure to make the pieces slightly oversize for best results



2 Clean oil, grease and oxides. Then grind slightly for thorough cleaning

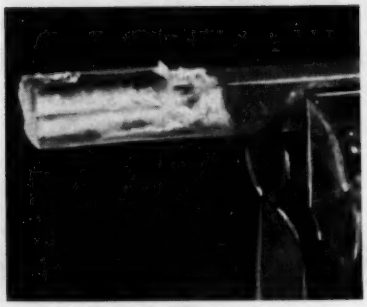
3 Spread flux to prevent metal from oxidation; flux helps metal wet easily

HOW TO

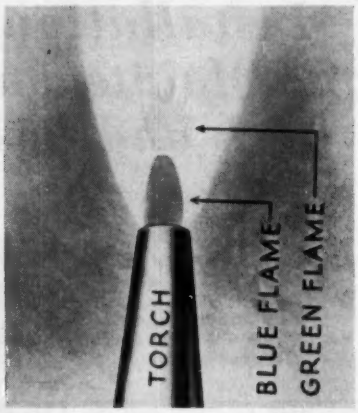
do silver-alloy brazing

► MOST MAINTENANCE MECHANICS use silver alloy for brazing on jobs around an industrial plant. Replacing high-speed tool tips is common so we'll show you how to do that. Big advantage of silver-alloy brazing: Melting point of silver alloy is low enough (under 1300 F) to avoid troublesome oxidaton or changing the heat treatment of tip or shank.

Made right, joint outlasts the tool. If a joint is stressed to failure point, the parent metal usually breaks before the brazing layer does. You need: (1) oxyacetylene torch (2) shop tools shown (3) silver brazing alloy (4) brazing flux. The brazing alloy should have good wetting characteristics with high-speed steel. Typical composition for this type alloy: 50% silver; 15.5 copper; 15.5 zinc; 16% cadmium; 3% nickel. To replace alloy in joint, use 0.003- to 0.005-in.-thick strip. For hand feeding, use 1/16-in.-diameter wire. General-purpose silver brazing flux is OK. —*Courtesy, Handy & Harman, New York, N. Y.*



4 Assemble the alloy strips and the tool tip in the recess for heating



5 Use large tip and reducing flame. A multitip torch spreads heat evenly

6 Start at under side, keep the flame moving until the piece is cherry red

7 When alloy is molten, use a warmed rod to move tip for complete wetting

Stop Algae Problems NEW simple, low-cost way

NEW Allis-Chalmers Algaecide kills all classes of algae and other microscopic organisms in cooling water

If you are troubled by slimes and algae in your cooling tower system, new No. 120 Series Algaecide is the answer. It is the most effective algaecide known. It eliminates such problems as plugged pump strainers, coated heat exchanger tubes, coated slats in cooling towers.

It is easy to introduce into the system by means of a pump, drip feed or manual feed.

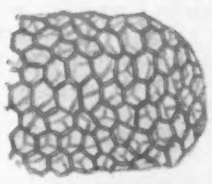
It is safe to handle. Even in concentrated form it is only a mild irritant to skin, eyes and mucous membranes.

Field tests prove that a 5-ppm concentration is toxic to most organisms.

Get complete information on No. 120 Series Algaecide. Call your nearest A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletin 28X8434.

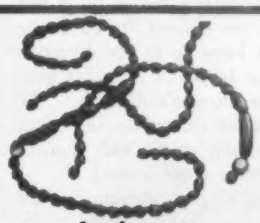
Call on
ALLIS-CHALMERS
for
Water Conditioning

As little as 2 ppm has killed all these algae



Hydrodictyon

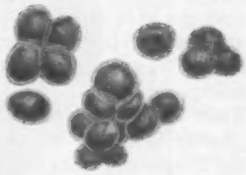
Microcystis



Anabaena

Oocystis

Chlorella



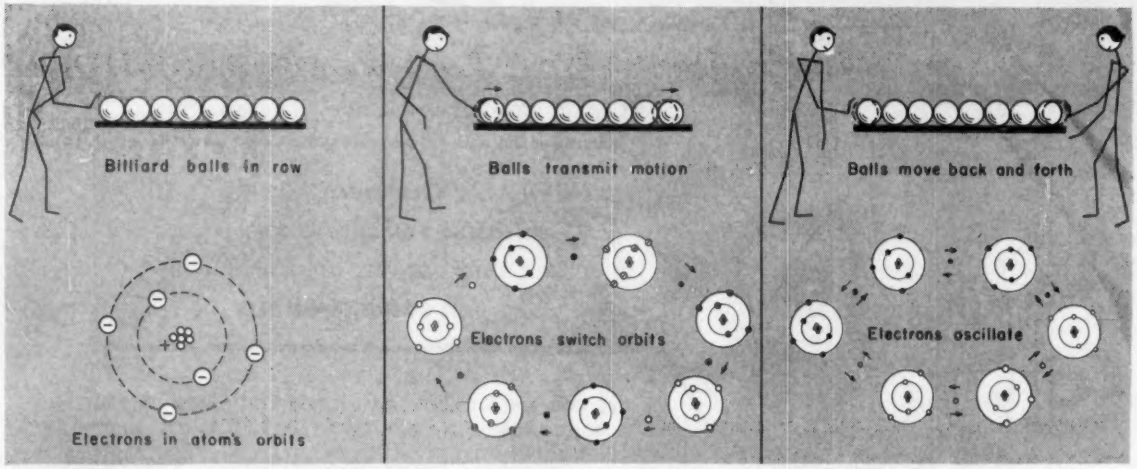
Protococcus

ALLIS-CHALMERS

A-5071

BASICS . . . *bringing engineering theory down to earth*

NORMAN PEACH, *Assistant Editor*



NO CURRENT FLOW. Electrons stay in their atoms, rotate around nucleus

DIRECT CURRENT. Electrons travel in one direction from atom to atom

ALTERNATING CURRENT. Direction of the electrons' travel reverses regularly

ELECTRICITY: 1

How electric current flows

POWER'S series of BASICS turns its attention to the theory behind the electric power that is generated, transformed, distributed and put to work in the modern industrial plant.

► WHEN an electric current flows, it carries energy. This is the property that makes electricity so useful. Chemical energy in a battery, mechanical energy in a generator, heat energy in a thermocouple, or light energy in a photocell can cause an electric current to flow. This current can flow for miles, and through very intricate circuits, and then be made to give up useful energy: light energy in a lamp, heat energy in an electric oven, mechanical energy in a motor, and chemical energy in an electroplating tank.

An electric current is a flow of electrons. Electrons are present all the time in every kind of matter—from copper wire to human bodies. Ordinarily these tiny particles of electricity remain in their atoms, each rotating in its orbit around the nucleus of its atom. But some of the electrons in some atoms are "loose" in their orbits, and under certain influences can be made to leave their orbits and start traveling.

When an electron leaves an atom, it doesn't get very far before it strikes another atom. It knocks an electron out of this second atom and slips into the ejected electron's place. The ejected electron does the same thing to a third atom, and so on through an electric circuit. The actual movement of electrons from atom to atom is slow, but the current starts to flow almost immediately. To understand how this can be possible, compare electrons to the row of billiard balls shown in sketches above. The balls are resting side by side. You may push the first ball only a fraction of an inch, but the last ball starts to move almost instantly.

Electric current flows in a circuit or loop. This means that the *last* atom to give up an electron is next to the atom that parted with the *first* electron, so the first electron's place is quickly taken by the last electron. Of course, a single chain of electrons doesn't make an electric current. Large numbers of electrons are involved, depending on size of the current.

Direct current flows when electrons keep traveling in the same direction around the circuit. When electrons flow for a short time in one direction and are then made to reverse their direction, there is an *alternating current* in the circuit. Here electrons shuttle back and forth.

In the early days of electrical discovery, before there was any electron theory, scientists thought current flowed in the direction opposite to what we now know to be the direction of electron migration. All the basic laws and formulas were developed around this idea of the current's direction. We keep this assumption today because correcting the error would cause more confusion than putting up with it does. It causes very little difficulty in power applications.

Following the early assumption, electric current is said to flow from a positive (+) to a negative (−) point in the external circuit. (The external circuit is the circuit outside the device, such as battery or generator, that causes current to flow.) Today, we know that electrons flow from a negative point (to which electrons are being supplied by the battery or generator) to a positive point (from which electrons are being taken away). When alternating current flows, points in circuit change regularly from positive to negative.

Next month: Fundamental units and Ohm's Law.

where throttled steam is a valve killing "vapor drill"

JENKINS PLUG TYPE VALVES
with the
500 BRINELL
STAINLESS STEEL
ARMOR SEAT
will
lower costs

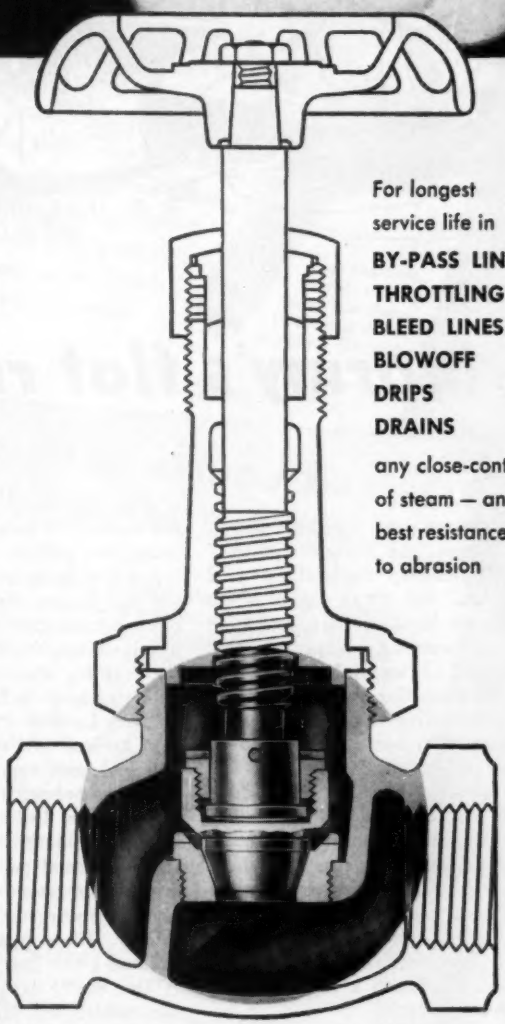
Closely regulated steam erodes grooves in seating units and drastically cuts service life of ordinary valves.

Jenkins Plug Type Valves have been engineered in every detail for maximum wear in such valve-killing service. The stainless steel Armor Seat defies the "vapor drill", and Jenkins quality throughout gives them top rating for wear-proof and trouble-proof perfomance.

Make you own test . . . in your toughest steam service . . . or anywhere that abrasion or erosion causes frequent valve failure. Compare, part for part, with any similar valve. You'll find that, again, Jenkins *extra value* pays off in longer life and lower maintenance cost.

Plug and seat ring are Jenkins JX500, a Stainless chromium alloy steel made to Jenkins high strength specifications, heat-treated to 500 Brinell. Seating surfaces are super-hard and mirror-smooth, offer highest resistance to galling, cutting, abrasion, and erosion. Wide, steep, 30° total taper permits extremely close regulation of flow and vapor-tight closure.

The Stainless steel plug is securely fastened to the spindle with a bronze locknut. Spindle is Jenkins specification bronze with a tensile strength exceeding 60,000 lbs., — has high corrosion resistance.



For longest service life in
BY-PASS LINES
THROTTLING
BLEED LINES
BLOWOFF
DRIPS
DRAINS
any close-control of steam — and for best resistance to abrasion

300 lb. 200 lb. 150 lb.
GLOBE and ANGLE

For complete information call your Jenkins Distributor — ask for Form 202-A. Or write: Jenkins Bros., 100 Park Ave., New York 17.

SOLD THROUGH PLUMBING-HEATING AND INDUSTRIAL DISTRIBUTORS

JENKINS VALVES
LOOK FOR THE JENKINS DIAMOND
SINCE 1864 TRADE JENKINS MARK
Jenkins Bros

Gullick picked up his ball-peen hammer and heaved it after Chuck, crashing the door

Marmy's flat ring

Mr M Surfaceblow

► "BILGEWATER on canned pumps, sealed pumps and leakfree pumps," roared Marmaduke Surfaceblow as I walked into his dingy office above O'Houlihan's Machine Shop & Engine Works last evening. What was that blast about? I wouldn't know. The crafty old consulting engineer was anchored to his swivel chair as usual, with his size-16 canal boats propped up on his tired roll-top desk.

Holding down the ship's settee along the wall were half a dozen burly characters. One had a black eye. Another had a bandaged right arm in a sling. All were swilling coffee from white porcelain cups. The battered coffeepot on the pot-bellied stove was steaming away full blast as usual. And the place was filled with a No. 4 Ringelmann smoke screen.

Having run No. 101 of Marmy's yarns in June, I dropped around to see if the old boy would make it 102. That announcement by Marmy as I stepped in told me I had arrived just in time. The salty mariners on the settee had their running lights respectfully focused on our hero. Not only that, but his shipmates also politely reduced their slurping a few decibels so they could hear his sage words. Marmy lit off a piece of rope yarn, gave his gray bowler the usual starboard list, looked challengingly at his audience, then continued bellowing away in his foghorn voice.

"Back in 1924, I was power engineer in a modern saw mill in Ottawa. The mill had been completely electrified a few years before. It had a 500-kw 550-volt 2-phase 3-wire alternator, driven by a steam turbine at 3600 rpm. Besides the usual power-plant auxiliaries driven by motors, the mill had squirrel-cage motors to run the production machinery. These motors were overrated and had a very low power factor.

"One wintry day during the rush season, the inboard slip ring on the alternator developed a bad brush. Before long, the ring had a flat spot. This called for an overtime job that night.

"Stanley Gullick, the machinist and general repair mechanic, was one of the best practical mechanics in those parts. The old boy was a natural with a knack for doing everything the easy way. While other mechanics made a Federal case out of a job, Charlie would dream up a way to do it simply. He'd often be finished while arguments were still going on about how the job should be done. You run into a guy like that once in a penguin's life. But Stanley had his faults.

"Because he could do things so easily 'by ear,' and his way was usually right, he was naturally suspicious of book engineers who could justify their arguments with a lot of long words. He was especially leery of young engineers just out of college—couldn't figure out why they were needed.

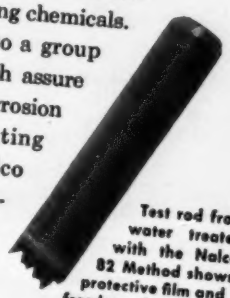
"'All them book guys do is sit up in the office with their slide rules and dream up crazy jobs,' Stanley would squawk. 'If they're so damn smart, why do they bring their screwy ideas to me to figger out?'

"At that time the mill had only one young college engineer, Chuck Nelson. He had the title of Assistant Superintendent and was a smart lad. His big-

(*Continued on page* 182)

Forest of Facts on Nalco® RECIRCULATING WATER TREATMENT

NALCO Laboratories' continuous research program has gathered this forest of facts about protecting recirculating water systems. In the search for the most effective *and economical* formula, the metal rods shown have been rotated in all types of recirculating waters and treating chemicals. Results pointed the way to a group of Nalco Treatments which assure users against scale and corrosion in virtually any recirculating waters. For details on Nalco Treatment to fit your particular system, call your Nalco Representative, or write direct.



Test rod from water treated with the Nalco 82 Method shows protective film and freedom from any scaling or corrosive attack.

THE Nalco 82 METHOD MAY BE THE ANSWER FOR YOU

The Nalco 82 Method is particularly suitable for scale and corrosion control in recirculating water systems which fall within the characteristic limits given here. Check them to see if your system should have Nalco 82 Treatment:

- Equipment to be protected contains steel and/or brass.
- Hardness of makeup water is more than 50 ppm; and sulphates and chlorides, as sodium salts, are less than 150 ppm.
- Calcium hardness of makeup can be as much as 500 ppm.
- Silica content of makeup water up to 50 ppm.
- Total alkalinity of makeup more than 40 ppm.
- Recirculation rates between 100 and 100,000 g.p.m.
- Where non-toxic waste water is required.

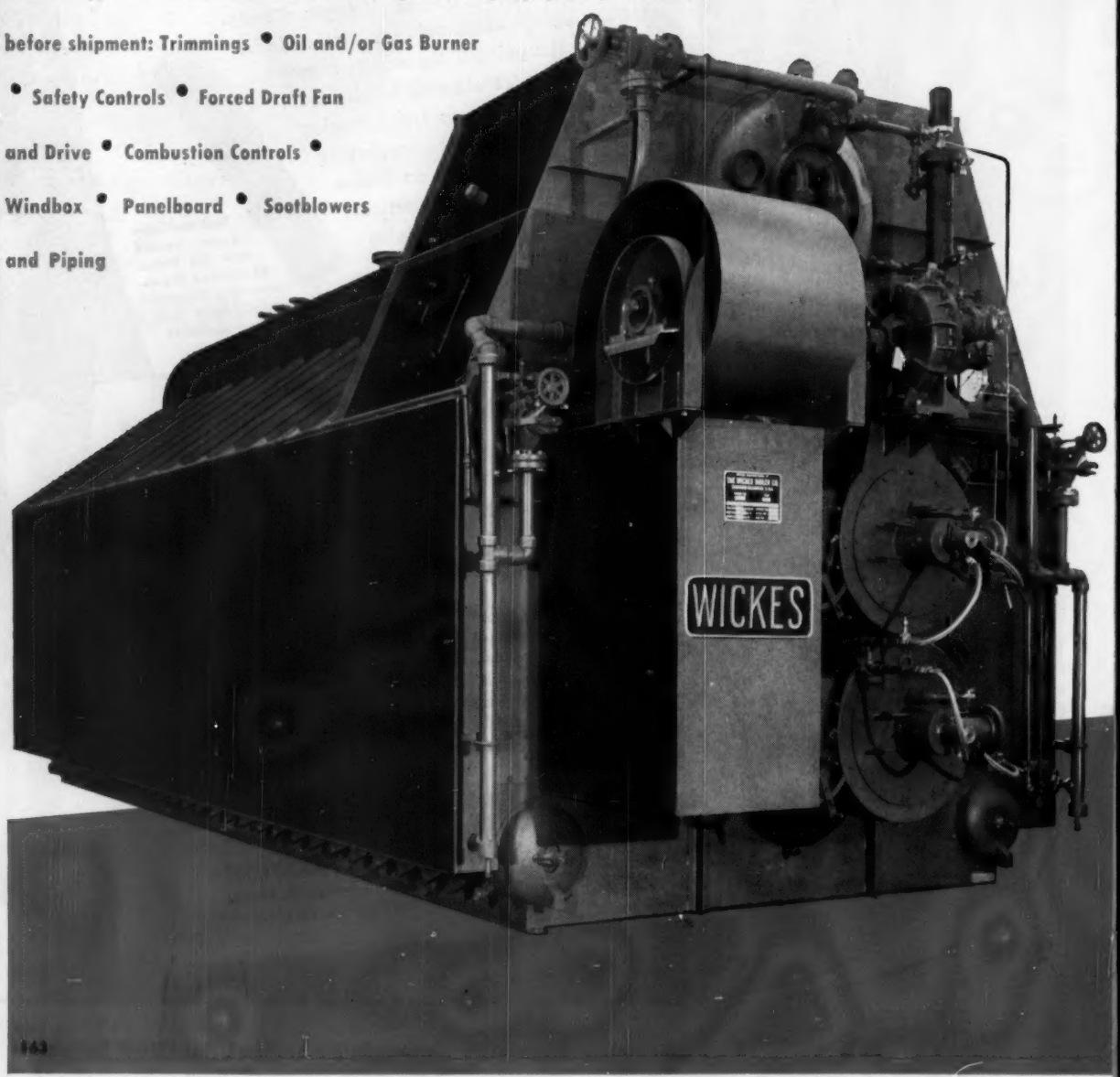
Act today to get the certain, low-cost protection of The Nalco System. Full data on Nalco 82 in free Bulletin 68.

NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

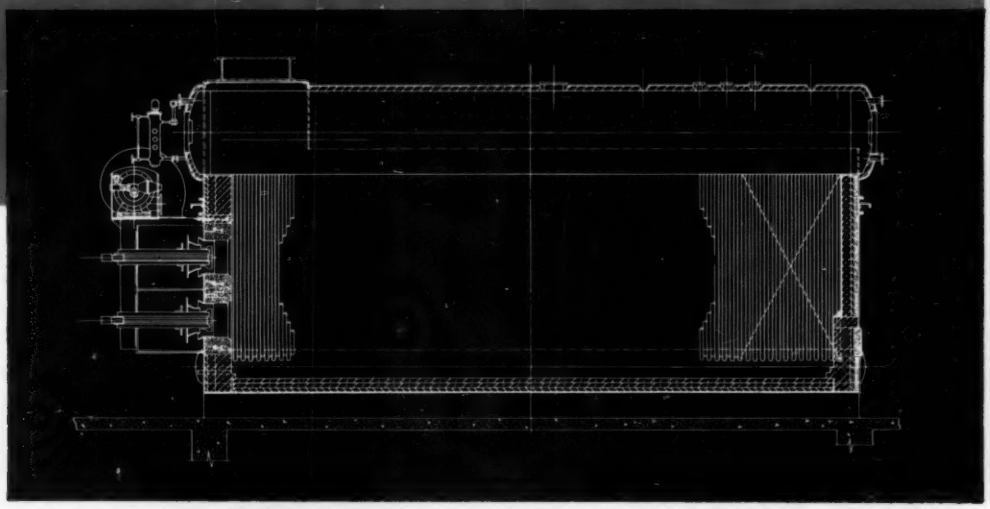
THE Nalco SYSTEM . . . Serving Industry through Practical Applied Science

NOW! 60,000 LBS. PER TYPE-A WATER TUBE by WICKES

Wickes Type-A Boilers include the following auxiliary equipment, installed before shipment: Trimmings • Oil and/or Gas Burner • Safety Controls • Forced Draft Fan and Drive • Combustion Controls • Windbox • Panelboard • Sootblowers and Piping



HOUR WITH A SHOP-ASSEMBLED STEAM GENERATOR



With capacities for sustained steam production up to 60,000 lbs. per hour the Wickes Type-A Boilers give you "packaged power" ready for immediate installation. They are custom engineered to your requirements and shop-assembled to reduce interruption of operations in your plant to a minimum. Wickes Type-A packaged boilers conserve headroom and floor space and are very simple in design . . . the large furnace is located between two banks of boiler tubes so that each furnace wall is a separate steam generator as well as an integral part of the boiler unit. The steam generator is enclosed in a high quality refractory and insulation setting and protected by a pressure-tight steel casing . . . thus, the pressurized furnace can be operated without a high stack or induced draft fan when burning oil or gas. This casing is also completely weatherproof for outdoor installation.

THE WICKES BOILER CO.

WICKES type A ES

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

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Reader service section

Start with these quick samples . . .

Trend toward automation . . .

is keynote at Dearborn Chemical Co's new Lake Zurich, Ill. plant. From time basic chemicals are received until they are packaged for shipment as compounded products, operation of the plant is almost entirely automatic. For full story turn to...

Reports From the Field, p 156

Serious contender . . .

for powering tomorrow's automobiles and other equipment is the free-piston engine combined with a gas turbine. Latest technical paper on the subject is briefed for your quick review. Other abstracts on electric motors, gas turbines, lubrication in...

Technical Briefs, p 158

More power on less fuel . . .

is a claimed feature of the Cummins turbocharged diesel that develops 335 hp. Key to high hp is the turbocharger that puts normally wasted energy of exhaust gas to work creating power. For more dope on this development, full pages on pumps, valves, plus a host of other problem-solving products, see...

Plant Equipment News, p 162

Pushbutton cooling . . .

by hermetic centrifugal refrigeration machines is theme of bulletin offered by Carrier Corp. Look for it in this month's listing of manufacturers' pamphlets—any of which can be had for your files by mailing the handy post cards provided.

Free Literature, p 171

Know where you're going?

A clearly marked road map will help you get there a lot quicker, safer. And so it is on the road of life—have you marked your road map or are you wandering aimlessly?

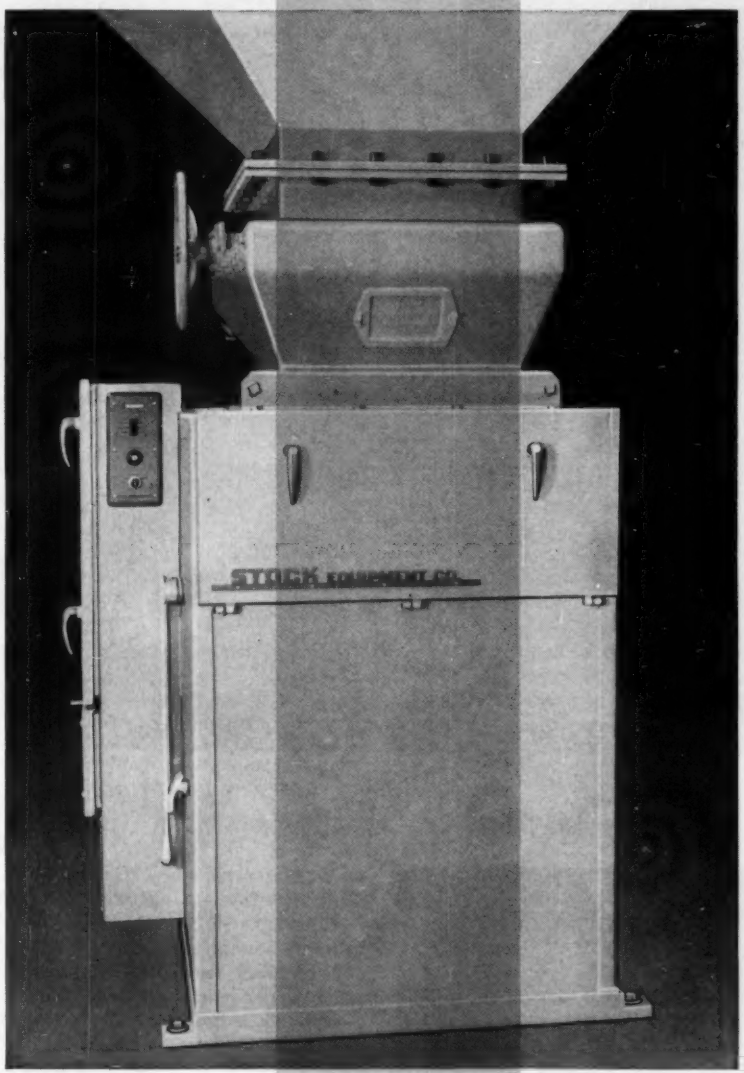
George Edwards, p 174

For other timely ideas, see following service pages ▶

THE NEW S-E-CO. MODEL 50

COAL SCALE is the only scale that carries a 24" width of coal through the scale without restriction

To meet the requirements of central stations and industrial plants that are using larger and larger boilers — and to move coal that is becoming more and more sluggish — Stock Equipment Company has developed their new Model 50 Automatic Dust-Tight Coal Scale.



The inlet is a full 24" inside square and the feed belt carries the coal straight through in an unrestricted 24" stream. The belt has the well known S-E-Co. endless, molded construction and is carried on closely spaced anti-friction idlers. This design allows it to handle the inlet loading (even under the largest bunkers) without danger of belt failure or shortened life.

The Model 50 includes many other new and advantageous features. Contact the Main Office in Cleveland or any of the local representatives to arrange for a conference to discuss these features in detail. Your next unit, whether it's brand new or part of a rebuilding program, deserves and needs the new S-E-Co. Model 50.

SPECIALISTS IN
BUNKER TO PULVERIZER AND
BUNKER TO STOKER EQUIPMENT

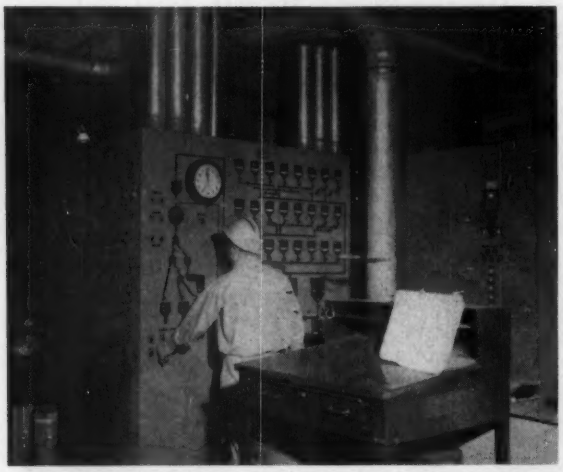
STOCK Equipment Company

745-P HANNA BLDG., CLEVELAND 15, OHIO

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 224



CONTROL PANEL of Dearborn plant is electrically-operated, works in connection with a bank of automatic weigh-scales

Dearborn opens new compounding plant

► REPRESENTING A MAJOR STEP in today's trend toward automation, the new Lake Zurich, Ill. plant of Dearborn Chemical Co features manufacturing processes that are almost entirely automatic. Although most of the plant construction had been completed in early 1955, it was necessary to make certain manufacturing refinements. Now the "shake down" has been completed and the plant is in full operation.

All materials are received in a common area from where they are conveyed to one of the plant's 36 storage bins. Each bin has a minimum capacity of one carload.

Heart of the plant is the electrically-operated control panel, photo left, that works in conjunction with a bank of automatic weigh-scales. A complete flow diagram of the plant is laid out on the panel, along with a series of small electric lights that indicate flow of material during the compounding operation. After the formula for a given product has been set on the automatic weigh-scales and the control panel activated, the chemicals are automatically fed out of the required storage bin in the order in which each weight requirement is set on the scales.

Chemicals are fed from each storage bin through a rotary vane feeder into a screw conveyor, and then into an automatic scale hopper. Drive motors for the screw conveyors are of the two-speed type. A reduction of speed occurs automatically when weight of the chemicals being delivered to the scale hopper comes within 50 lb of desired weight. Remaining 50 lb are "dribbled" in—preventing overweighing of the chemicals required for the formula being compounded.

After ingredients have been delivered to the scale hoppers and the scales "zero out" the materials are conveyed automatically to a mixer. A relay is activated to attain a predetermined mixing time. After mixing, discharge door of the mixer is automatically opened and the batch is conveyed directly to one of three drumming hoppers. The hopper to be used is selected by the control panel operator.

At this point, a sample of the compounded product is taken to the plant's Control Laboratory where it is analyzed to determine precise adherence to specifications and consistency in quality.

The product is discharged from the drumming hopper into kegs, drums or bags, as desired. When filled to the correct weight, these containers are moved on roller conveyors directly to freight cars or trailers at the plant's shipping dock.

Cora Sanders retires, Art Sommer made Assistant Editor

Assistant Editor A P Sommer

► AFTER SERVING since March 1954 as Editorial Assistant on the staff of POWER, Arthur P Sommer, as of August 1, steps into the position on the copy desk formerly held down by Assistant Editor Cora Sanders. For some 13 years Cora Sanders has been in charge of copy editing, a key spot on every major publication. She retires as of August 3 after a long career in the publishing field.

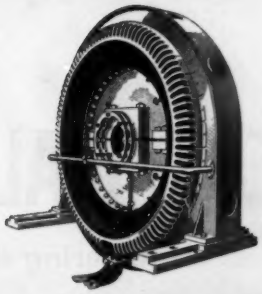
Art, a graduate of Rider College, holds a degree in journalism. His fine work as Editorial Assistant proves his ability to assume the full responsibilities of Assistant Editor. In addition to heading up the copy operation, Art will have the immediate responsibility of further developing all departments in the Reader Service Section.

Nuclear reactor for industrial research begins operation

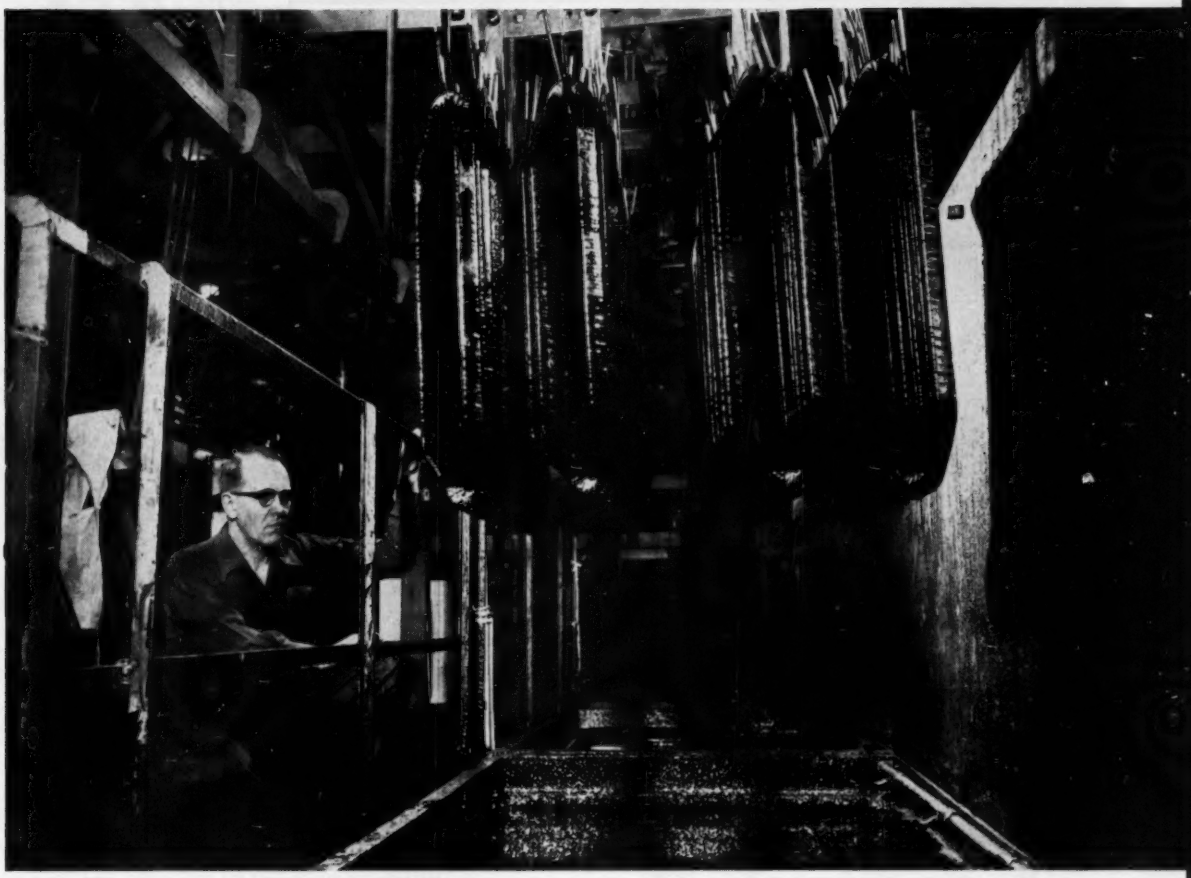
► THE NATION'S first private nuclear reactor for industrial research has gone into operation. The 50,000-watt installation, designed and built by Atomics International, a division of North American Aviation, Inc, for the Armour Research Foundation, is intended solely for peacetime use by industry.

Located on the campus of Illinois Institute of Technology, the reactor opens an entirely new field in industrial research and development by providing an on-the-spot source of high-energy gamma rays and neutrons. Short-lived radioisotopes, useful in medical, industrial and scientific research, will be available locally from the reactor. It

(*Continued on page* 222)



HOW G-E SYNCHRONOUS MOTORS REDUCE MAINTENANCE COSTS



An insulating bath helps fight moisture

Moisture has the unhappy habit of working its way through motor coil insulation and reducing its capacity to withstand voltage stress. To guard against exasperating production-line shutdowns, General Electric seals coils with a coating of high-grade insulating resins. This seal is applied by a conveyor belt dip and bake system.

It works like this. After the main body of insulation is applied in the form of tapes and films of non-hygroscopic materials, each set of coils is placed on a conveyor and dipped in a bath of special, synthetic insulating materials. This way the coating is uniformly applied. Then the conveyor carries the coils into a huge oven and cures them for a specific length of time. The cycle is repeated until the proper seal is built up. Each step is automatically and precisely controlled—length of dipping and baking time and temperature.

This means the coils on your G-E synchronous motor are protected by a hard, tough insulation with high dielectric strength and high resistance to moisture and contaminants. Its glossy surface makes the coils easy to clean too.

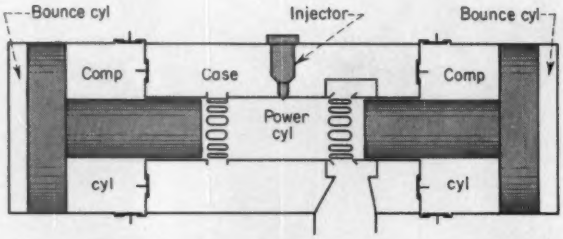
All this adds up to less maintenance and down-time. For more information on G-E synchronous motors, contact your nearest General Electric Apparatus Sales Office or write Section 775-4 for Bulletin GEA-5332. General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

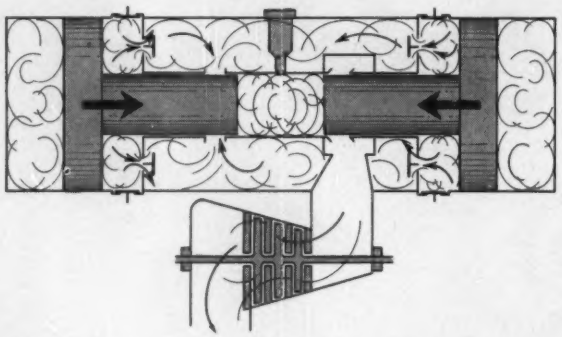
TECHNICAL BRIEFS

Latest engineering developments for busy power men

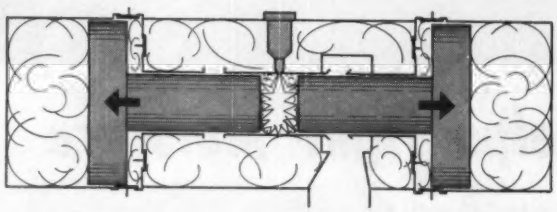
14 Papers for you on
ELECTRIC MOTORS
GAS TURBINES
BEARING LUBRICATION
GEAR LUBRICATION



PISTONS START STROKE. Intake and exhaust ports are open



STARTING-AIR pressure admitted to the bounce cylinders



FUEL INJECTION and the start of combustion in cylinder

New free-piston engine for small gas turbines

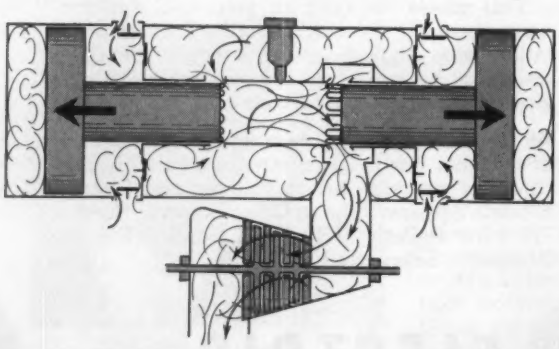
The GMR 4-4 "Hyprex" engine—A concept of the free-piston engine for automotive use. *By A F Underwood, General Motors Research Staff.*

The free-piston engine combined with a gas turbine has many attractive features for automotive use. Analysis of test results of this type of an engine in an automobile definitely indicate it will be a serious contender for powering automotive vehicles. Moreover, the author feels that evidence obtained to date suggests that many engineering organizations will follow this field.

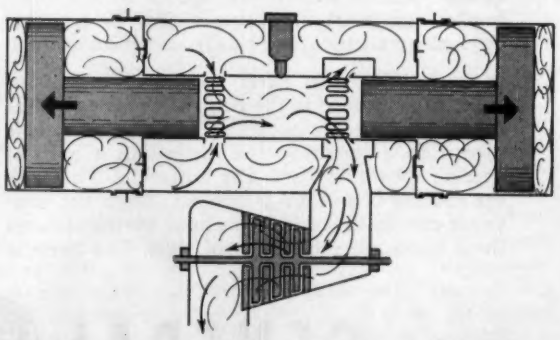
Surprising to some, the basic engine is over 30 years old and has been developed to the position of having hundreds of machines in operation throughout the world. All these are either 1000-hp engines or portable air compressors. The engines are rather large and heavy in relation to their output.

The project reported in this paper describes a completely new design developed for automotive applications. It is based on the concept of a small lightweight engine of 250 hp and is the first Siamesed unit ever built. This configuration was chosen to secure a compact machine of light weight with improved thermal efficiency and reduced noise.

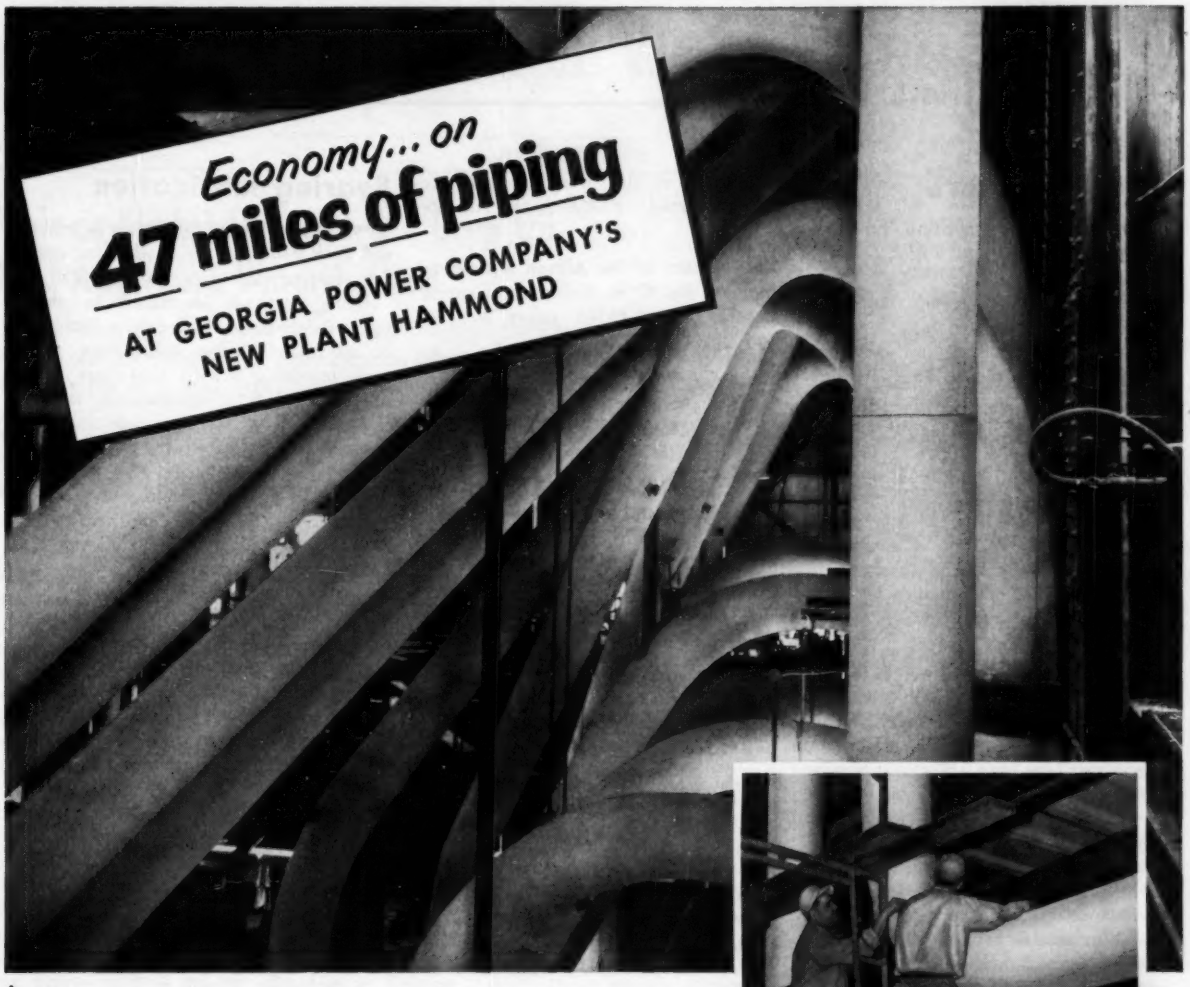
The paper summarizes advantages of the free-piston engine and then gives a complete description of this new unit. *SAE paper No. 765.*



BOUNCE-CYLINDER air is compressed at the end of stroke



CASE AIR scavenging the power cylinder of exhaust gas



47 miles of Johns-Manville 85% Magnesia Insulation boosts operating efficiency of Plant Hammond, one of the South's largest and most modern private utility installations.

Insulating feed water line at Plant Hammond. Contractor for this job was Brooks-Fisher Insulating Company of Atlanta, Georgia.

J-M 85% Magnesia Insulation helps cut fuel rate 25% below national average

Officials of the Georgia Power Company were gratified when the coal rate of their new Plant Hammond worked out at 0.75 lb. per KW HR, 25% below the national average. In their annual *Electrical Industry Statistics, Electrical World* had reported that increased efficiency in the techniques of power production has lowered the average coal rate to 1 lb. per KW HR. in 1954.

An important factor contributing to Plant Hammond's high efficiency was the selection of insulation. Johns-Manville's 85% Magnesia was applied in the most economical thicknesses throughout the plant for all piping and equipment operating in its temperature range. At higher temperatures 85% Magnesia was used in combination with J-M Superex® diatomaceous silica insulation.

This is only one of thousands of case histories where J-M 85% Magnesia has helped industry achieve outstanding fuel savings and increased operating efficiency. In all types of manufacturing and processing plants it is the standard for temperatures to 600F . . . providing high insulating value, easy application, long life, initial low cost and minimum maintenance. Write today for further information on J-M 85% Magnesia and Johns-Manville's complete drawing-board-to-job-site insulation service. Address Johns-Manville, Box 60, New York 16, New York. In Canada, Port Credit, Ontario.

Johns-Manville *first in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

More TECHNICAL BRIEFS

Begins on page 158

Electric motors

Synchronous motor starting performance calculation *By J C White, General Electric Co.*

Disadvantages of various computing methods are eliminated, to a considerable degree, by use of digital or analog computing machinery. The growing trend in engineering design today is to use more exact methods to replace routine calculations formerly made by slide rule. Synchronous-motor starting performance is an excellent case in point and is discussed in this paper. Widespread use of digital computers should make it standard practice to compute starting performance by more exact methods. *AIEE paper No. 56-154.*

Relay protection of motors in steam power stations with 4-kv grounded neutral systems. *By W F Neff, Ohio Valley Electric Corp, S H Horowitz, American Gas and Electric Service Corp, and R B Squires Westinghouse Electric Corp.*

This paper gives a number of general conclusions of much interest for the 4-kv system. These include: Provide short-circuit protection with instant tripping. Instantaneous settings should be above maximum inrush, but should not exceed one-third of the total fault current.

Phase overload relay current settings should be determined by the normal operating current. Lever settings of these relays should be just high enough to allow starting, plus sufficient margin for emergency overloads. *AIEE paper No. 56-165.*

Gas turbines

Gas-turbine rotary regenerator — design and development of prototype unit for 3000-hp plant. *By W E Hammond and T C Evans, The Air Preheater Corp.*

To exploit the regenerative gas-turbine cycle to the fullest extent possible requires an extremely high degree of heat exchange. At present, the rotary heat exchanger is the only type that can be designed with the high thermal effectiveness necessary and yet remain practical from a size and cost standpoint.

This paper emphasizes advantages of the regenerative cycle and shows why the rotary heat exchanger is so promising, particularly in the high effectiveness range. Certain data pertaining to the design of the prototype unit are also presented. *ASME paper No. 56-GTP-5.*

Development of the Allison turbo-prop engine. *By G E Holbrook, General Motors Corp. ASME paper No. 56-GTP-17.*

Internally fired semi-closed cycle gas-turbine plant for naval propulsion. *By S H DeWitt and W B Boyum, Westinghouse Electric Corp. ASME paper No. 56-GTP-16.*

An experimental arrangement for the measurement of the pressure distribution on the high-speed rotating blade rows. *By Prof Dr Ing K Leist, Technical University, Aachen, Germany. ASME paper No. 56-GTP-13.*

Rotary regenerator for gas turbines. *By J C Miles and R L Smoot, University of Illinois. ASME paper No. 56-GTP-9.*

A new Solar gas-turbine driven auxiliary power plant. *By R Kress, Solar Aircraft Co. ASME paper No. 56-GTP-8.*

Effect of ambient and fuel pressure on nozzle spray angle. *By S M De Corso and G A Kemeny, Westinghouse Electric Corp. ASME paper No. 56-GTP-3.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39 St, New York 18, New York.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

American Society of Automotive Engineers. Identified by initials SAE. Information as to availability from SAE, 29 W 39th St, New York 18, New York.

American Society of Lubrication Engineers, identified by initials ASLE. Information as to availability from ASLE, 84 E Randolph St, Chicago, Ill.

Bearing lubrication

Spray application of lubricants to plain roll neck bearings. *By C M Winn and J S Aarons, United States Steel Corp.*

Using methods described in this paper it is possible to secure a number of advantages when lubricating roll neck bearings. Briefly, these are (1) reduction of lube consumption by at least 50% (2) less downtime for adjustments (3) less wear of roll necks (4) longer bearing life (5) reduced machine-shop time because of longer bearing life. All these add up to a single thought—savings. *ASLE paper; no number.*

A review of some hydrodynamic applications. *By Ernest K Gatcombe.*

This paper presents a brief review of some important hydrodynamic lubrication applications. Three types of common lubrication problems are discussed—gear teeth, thrust bearings and sleeve bearings. There is also a brief discussion of some newer applications. *ASLE paper; no number.*

Grease flow in shielded bearings. *By R O O'Halloran, J J Kolfenbach and H L Leland, Esso Research and Engineering Co.*

A technique, based on dye tracers, for measuring soap and oil components of a grease in shielded-bearing lubrication has been developed. Use of the technique in small, high-speed bearing tests shows there is substantial movement of grease between the bearing and shields. Grease moves between the bearing and shields as an entity. *ASLE paper; no number.*

Gear lubrication

Design and testing considerations of lubricants for gear applications. *By E E Shipley, General Electric Co.*

The tendency in the gear industry today is toward high-capacity gearing. More load, less weight and higher speeds are stressed to the extent that many gear designs are completely dependent on the lubricant available. In effect, the lubricant has become a constructional gear material.

Real block to higher load-carrying capacity seems to be an inadequate understanding of the lubrication phenomena. Work has been done to investigate the types of gear failures related to the lubricant. These are wear and scoring. *ASLE paper; no number.*

Hall Industrial Water Report

VOLUME 4 AUGUST 1956 NUMBER 4

Scale or Sludge Deposits Can Crop Up Most Anywhere Water is Used

When they do, the water detective must find the cause and the cure. Sometimes the problem is run-of-mine. More often, however, it brings into play his skill and experience as a specialist in dealing with water.

Cold Niagara Revealed as Offender

As winter cold deepened, a chemical manufacturing plant on the Niagara River, a Hall client for many years, suddenly experienced a hard glassy deposit in the plant intake and distribution system. Pumps had to be removed from service for cleaning. Mechanical cleaning had no effect, but when the pumps were heated with steam the deposit softened and washed out.

G. H. Smith and R. E. Elliott, Hall engineers in the Buffalo office, found that the Niagara River water at the plant intake showed greater than normal values for calcium, alkalinity and pH, indicating contamination by an alkaline calcium-bearing material. However, this information did not explain the fact that calcium carbonate was being deposited in the cold sections of the system rather than at points where the water was being heated.

Elliott called J. P. Kleber at the home office in Pittsburgh for an opinion. From past experience, Kleber had the answer immediately. Hexahydrate of calcium carbonate! —a quite uncommon material. Temperatures below 40F plus some free hydroxide alkalinity in Niagara River water had precipitated this compound. When the temperature was elevated, the material lost its water of hydration and left a relatively soft calcium carbonate mud.

How to prevent the deposit? Nothing could be done about the contamination or the winter temperature of the incoming water. While treatment of this water with 5 ppm of Calgon® would keep the scale from forming, in-plant changes appeared to be less costly than chemical conditioning. Well-pleased with the diagnosis and suggestions, the plant went ahead with these changes.

Desuperheater Develops Deposit

At a lumber plant in Oregon a low-pressure turbine using desuperheated steam suffered a substantial decrease in capacity. Inspection of the desuperheater and the steam line beyond it revealed the presence of deposits an inch thick.

R. T. Manion, Hall field engineer in Portland, uncovered the fact that during the night there was insufficient condensate for desuperheating, so raw water was being used to supplement it. Evaporation of this raw water deposited the solids it contained in the desuperheater, steam lines and turbine.

Further investigation produced a practical answer to the problem. During the day there was more condensate than required for desuperheating, so Manion recommended storing the excess for use at night. Now the plant has sufficient condensate for desuperheating at all times. As a result, turbine capacity remains constant and the former difficulties with valves, strainers and traps are no longer experienced. A recent inspection of the desuperheater showed it to be clean.

Midwest Power Co-operative Eliminates Manual Cleaning Of Preheater Trays

Hand chipping of hard, white scale from their evaporator preheater trays was a time-consuming monthly task at a midwest power co-operative. J. F. Nelson, Hall field engineer in Kansas City, suggested changes in points of chemical feed ahead of the preheater in order to obtain good mixing of the conditioning chemicals before the water reached the preheater. He further recommended the feeding of 5 ppm of Hagan Dispersive®.

Since the start of dispersive feed a 30 percent increase in evaporator capacity has been noted because of cleaner heat transfer surfaces. Also when the preheater trays were cleaned after three months' operation the deposit found was so soft it could be removed with the fingers. Further changes have been recommended which should result in even greater improvement in conditions.

Hospital Reports Condition Of Boilers Excellent

When a hospital on Long Island, New York, decided to increase steam generating capacity, Hall Laboratories was invited to provide water conditioning service for the expanded boiler plant.

Hall field engineer R. A. Beardsley found that the old boilers contained a considerable amount of scale difficult to remove by mechanical cleaning even though the make-up water had been zeolite softened and phosphate and soda ash had been used for internal conditioning. Serious tube difficulties had been averted simply because the boilers had been operated at very low ratings.

After three years of cooperative effort with Beardsley, the Chief Engineer at the Hospital reports, "The new boilers are free of scale and corrosion. The scale has been removed from the old boilers and it is now possible to operate during the off-heating season with only one boiler at greatly increased fuel efficiency."

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

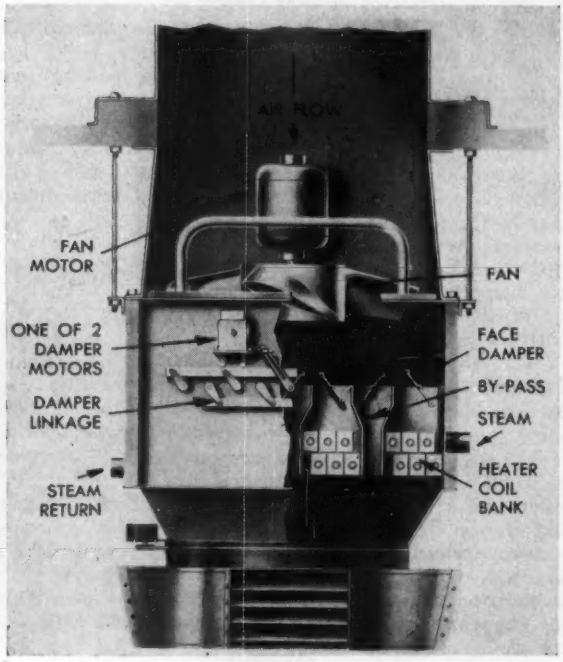
Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

PLANT EQUIPMENT NEWS

Your information center for new products designed to solve plant problems

Published monthly as a service to readers



Unit heaters with fresh air supply

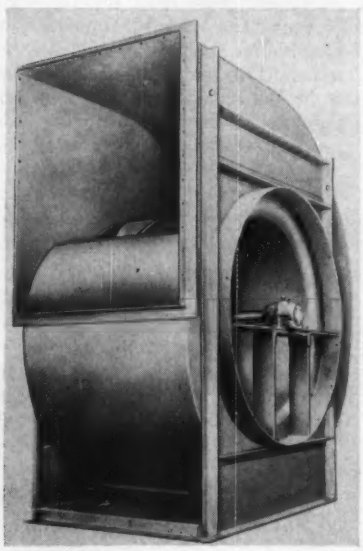
801 • Units are designed for the replacement of air exhausted in manufacturing processes and for the comfort of workers. They consist of a motor and fan, a heater section comprising alternate heating and by-pass passages and a distributing outlet. Air brought in through heating passages passes over extended surface steam coils. Air brought in through by-passes is not heated.

Volume control dampers on all passages, operated by synchronized damper motors, are actuated by an air-stream or room thermostat. Dampers on heating passages move toward open position and dampers on by-passes toward close position or vice-versa, depending on temperature needs. When outside air temperature is lower than desired inside temperature, dampers on heating passages open and those on by-passes close to the degree necessary to produce required temperature. Blended discharge air stream is maintained at an even predetermined temperature and constant volume. Spring-return feature closes both sets of dampers when fan motor stops—separate shut-off dampers are not needed.

Steam pressure in coils and supply main is same at all times. Consequently, coils can't freeze and burst as is always a threat where steam pressure is modulated to regulate temperatures. Both vertical and horizontal units are available. Write manufacturer for bulletin FAS-1.

L J Wing Manufacturing Company, Linden, N. J.

For more data on these items, use post cards on page 171. Identify your request with item number.

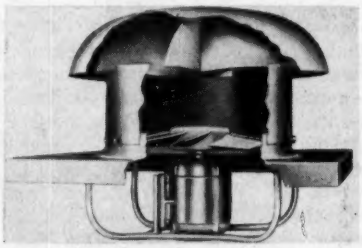


Airfoil centrifugal fans

802 • *Series 6000 Silentvane* fans reportedly make possible 92 percent peak mechanical efficiency and 88 percent static efficiency in movement of air in high-pressure air conditioning, industrial process ventilation and vehicular tunnel ventilation. Airfoil-type blading is claimed to lower noise energy perceptibly as compared to conventional flat-bladed centrifugal fans. The fans are designed for direct connection to conventional squirrel-cage induction motors operated at standard motor speeds.

Sixteen fan models are offered with wheel diameters ranging from 27 to 108 in. Further information available on request to the manufacturer.

Westinghouse Electric Corporation, Sturtevant Div, 200 Readville St, Hyde Park, Boston 30, Mass.



Axial roof ventilator

803 • Airfoil fan blades and a specially vaned head combine to minimize noise and turbulence of these *Silent-Vent* units, according to manufacturer. The mushroom-shaped head is 1½ ft high; fan blade diameters range from 9 to 48 in. Motor-fan outputs reportedly can exhaust 350 to 34,430 cu ft of fumes, smoke and dust per minute.

Detroit Blower Co, 9867 Pacific Ave, Franklin Park, Ill.

For More Equipment News, turn to pages 164, 166, 168 ►

They licked a problem—before it happened—with STANODIESEL Oil M

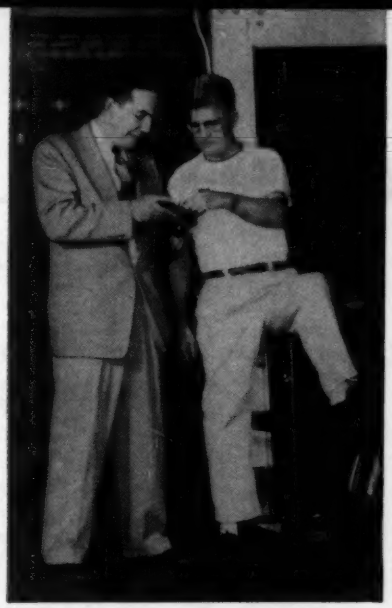
How Sturgis light plant planned ahead to eliminate source of possible power shut down

Sturgis, Michigan, light plant management in 1946 determined that it might be difficult to satisfy all power requirements if the light plant's large engine, or more than one of its small engines, was down. The plant is equipped with 5 engines—four GM 1,600 H.P. and one Busch-Sulzer 2,475 H.P. Plant management rightly figured that one of the keys to the problem was good lubrication. So, in 1946, STANODIESEL Oil M was tested in one General Motors engine.

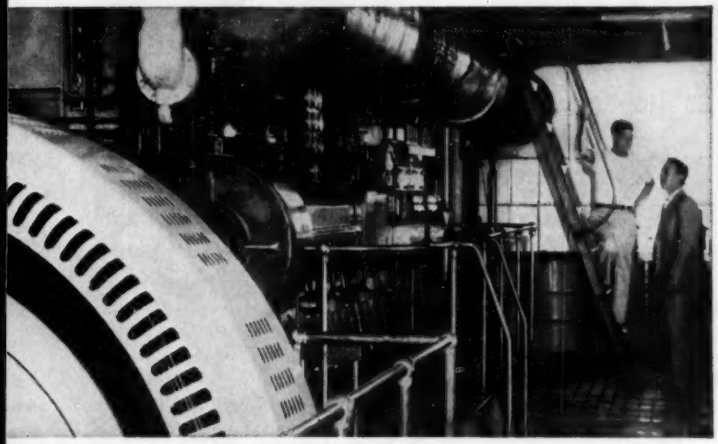
In 1947, based on its performance during the test, all engines were converted to STANODIESEL Oil M. In the nine years since, the plant has never had to shut down power to customers because of engine or oil failure. There have been no wear problems. Engines have stayed clean. There is no ring sticking. Bearing life is exceptional.

STANODIESEL Oil M can give this kind of performance for two big reasons: (1) its highest quality base stock, (2) its additive formula. STANODIESEL Oil M has superior stability. An oxidation inhibitor helps to prevent unwanted increases in oil viscosity. Detergent-dispersant additives keep crankcase, pistons, cylinder walls and other parts clean. An anti-foam agent controls foam.

There's a Standard Oil industrial lubrication specialist near you in any of the 15 Midwest or Rocky Mountain states. Call him for more information about STANODIESEL Oil M. Or write Standard Oil Company, 910 S. Michigan Avenue, Chicago 80, Illinois.



J. J. Threlfall, superintendent and Donald Cripps, Standard Oil lubrication specialist check Don's data book on Sturgis light plant diesels. Don is well qualified as a lubrication specialist. He has been doing this work for nine years. He has an engineering degree from Michigan State University and is a graduate of the Standard Oil Sales Engineering School.



Sturgis, Michigan, light plant has four GM 1,600 H.P. engines and this Busch-Sulzer 2,475 H.P. engine. Engines receive progressive maintenance at 3,500 to 4,000 hours. STANODIESEL Oil M is used in all engines.

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate areas and parts.
- Eliminates spark plug fouling in spark ignited engines and reduces combustion chamber ash deposits in engines burning natural gas, LPG and liquid fuels.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil commingle.

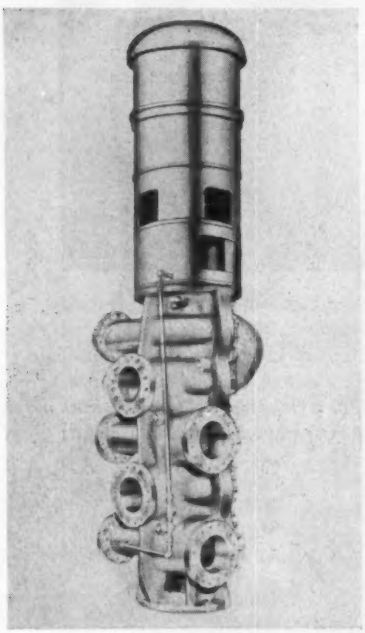
STANDARD OIL COMPANY
(Indiana)

STANDARD

More EQUIPMENT NEWS

Begins on page 162

PUMPS—Five units for varied industrial applications

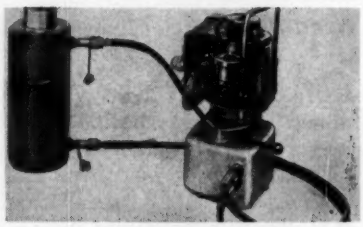


Vertical condensate pump has four pumps in a common case

805 • Vertical multi-unit condensate pump features four pumps in a common case, utilizing a common shaft. It has eight flanges—four intake and four discharge. Four-pumps-in-one design was reportedly developed to (1) save floor space (2) realize economies of a common driver (3) increase reliability because use of four pumps on common shaft requires only a single stuffing box—reduces packing maintenance.

Three of the pumps are single stage, the fourth is two stage with an external crossover. Unit is driven by a vertical electric motor. Axial and radial hydraulic balance is obtained by using double-suction impellers and double-voluted pump cases. Rotating element can be removed without disturbing suction or discharge piping.

Byron Jackson Pumps, Inc, Box 2017A, Terminal Annex, Los Angeles 54, Calif.

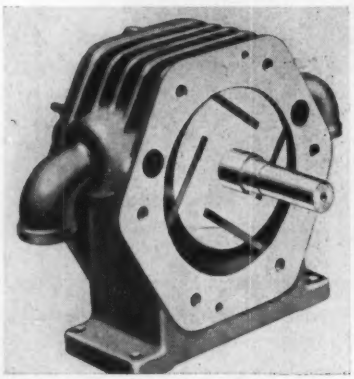


Lightweight hydraulic pump

806 • Gasoline - operated hydraulic pump is designed for use with all single or two-way *Simplex Re-Mo-Trol* hydraulic rams. The power pump with a displacement of 30 cu in. of oil per minute reportedly will raise a ram five times faster than a hand pump with displacement of 6 cu in. of oil per minute.

The unit has a 1½-hp gasoline engine that provides continuous operating pressure of 5000 psi and intermittent pressure to 10,000 psi.

Templeton, Kenly & Company, 2525 Gardner Rd, Broadview, Ill.

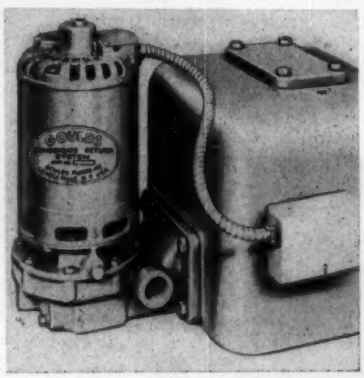


Bronze rotary pump

807 • Corrosion-resistant unit is designed for vacuum and/or pressure applications in handling steam, hydrogen, natural or manufactured gas, nitrogen or other inert gases carrying entrained moisture. Bronze construction of rotor and housing reportedly eliminates "freezing" due to water-vapor corrosion at the rotor extremities and housing end-plates.

Pump's *Graphitar* vanes require no lubrication in riding against cylinder wall, eliminates danger of sparks.

Dexter Folder Co, Pearl River, N. Y.

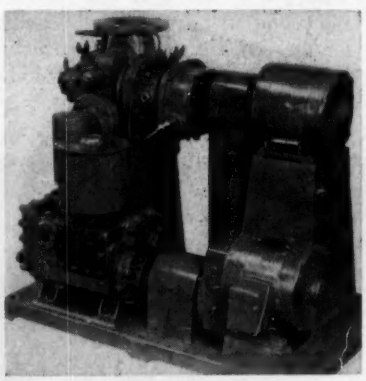


Condensate-return systems

808 • Series of condensate - return pumping units are available for both closed low-pressure steam heating systems or process equipment and for boiler feed condensate return. Single and duplex units may be obtained.

Straight condensate return units receive, and automatically return to the boiler, condensate from various types of low-pressure steam heating systems and process equipment. Boiler feed system automatically blends raw make-up water with hot-return condensate.

Gould Pumps, Inc, Seneca Falls, N. Y.



Two-stage high-vacuum pump

809 • This small version of company's 2-stage mechanical booster high-vacuum pump is reported to maintain uniformly high pumping speeds over a wide range of pressures. A baffled interstage connection is provided between the two pumps and both pumps and motors are mounted on a common base.

Pumping speed of 150 cfm is maintained over a broad pressure range from 200 to 3 microns. At 0.1 micron, pumping speed is 95 cfm. Request details.

Kinney Mfg Div, The New York Air Brake Co, Boston, Mass.

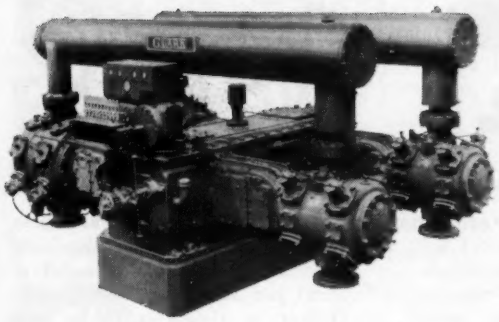
For more data on these items, use post cards on page 171. Identify your request with item number.

any flat means trouble

but in plant air supply it also means lost production!

Unless your plant air supply has adequate capacity in reserve, you may actually slow down your entire production every time you add a new labor-saving air-operated tool or device.

New increased demands on overloaded or overextended air supply inevitably cause a pressure drop all along the line. That means every tool, chuck and wrench slows down . . . and production suffers.



When did you last check your air at the *end* of the line? If it is going "flat," a Clark Balanced/Opposed Air Compressor will restore full pressure and, at the same time, *provide for a planned reserve to take care of future demand.*

There is a Clark Representative near you ready to give you all the facts. Why not call him now or write for your copy of Bulletin 118?

CLARK BROS. CO., OLEAN, N. Y.
One of the Dresser Industries
Offices in principal cities throughout the world

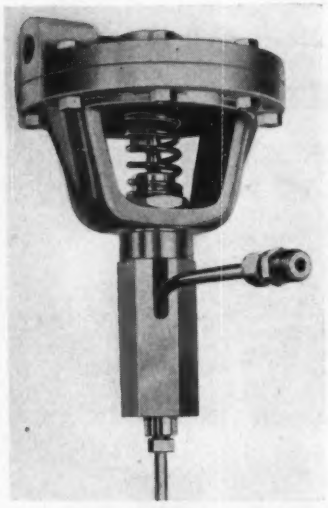
CLARK®

Balanced
Opposed
Compressors

More EQUIPMENT NEWS

Begins on page 162

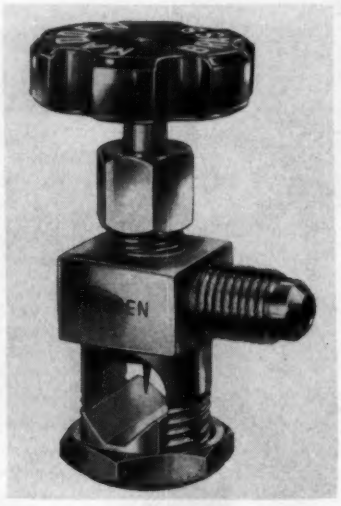
Six possible solutions to your valving problems



Process control valve

810 • Unit handles erosive process flows or flows containing gritty solids that can't tolerate pockets but can accept neoprene or natural rubber. It produces minimum turbulence in flow through the valve and is for use on slurry service where solids in suspension tend to plug conventional valves. Details from manufacturer.

George W Dahl Co, Inc, 430 High St, Bristol, R. I.



Tube-piercing valve

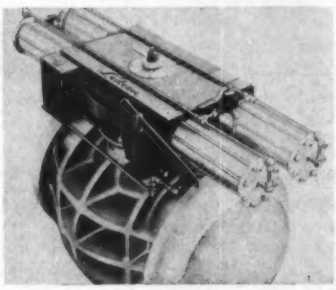
811 • Claimed features are (1) one-piece brass body made from extruded bar (2) recessed sealing gasket that can't slip or fall out. The valve pierces 3/8, 7/16 and 1/2 in. od tube and can be installed in any position on copper, aluminum or thin wall brass tube wherever a liquid, gas or air flow is desired.

Madden Brass Products Co, Aurora, Ill.

Non-corrosive solenoid valve

812 • "In-line" construction of this 2-way direct-solenoid-controlled valve makes it easy to inspect and service. All control parts can be removed in one assembly—without disturbing piping. Unit is primarily designed for ac applications. Normally closed, it is available in standard pipe sizes, 1/4 through 2 in.

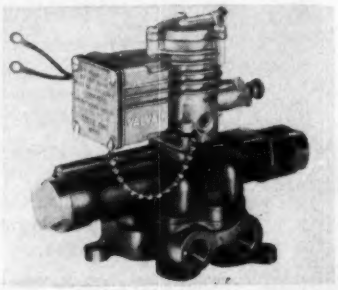
Airmatic Valve, Inc, 7317 Associate Ave, Cleveland, Ohio



4-cylinder valve actuator

813 • Unit is built to operate high-pressure plug and ball valves up to 36 in. Features claimed include (1) balanced torque delivered to valve stem through 4-cylinder operation (2) entirely separate gas and oil systems (3) easy field installation without modification of plug valve. Request details from manufacturer.

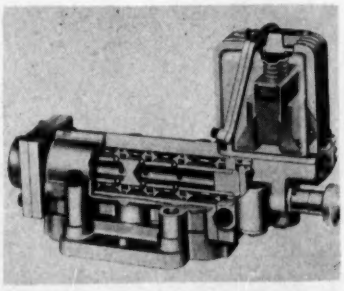
Ledeen Manufacturing Co, 1600 S San Pedro St, Los Angeles, Calif.



Solenoid control valve

814 • Solenoid pilot-operated unit has a moisture and dustproof solenoid enclosure that seals out splashing liquids or airborne contaminants. A safety solenoid cover renders the valve electrically inoperative when cover is removed. Integral junction box will accommodate 6-in. taped pigtail leads.

Valvair Corp, 454 Morgan Ave, Akron 11, Ohio

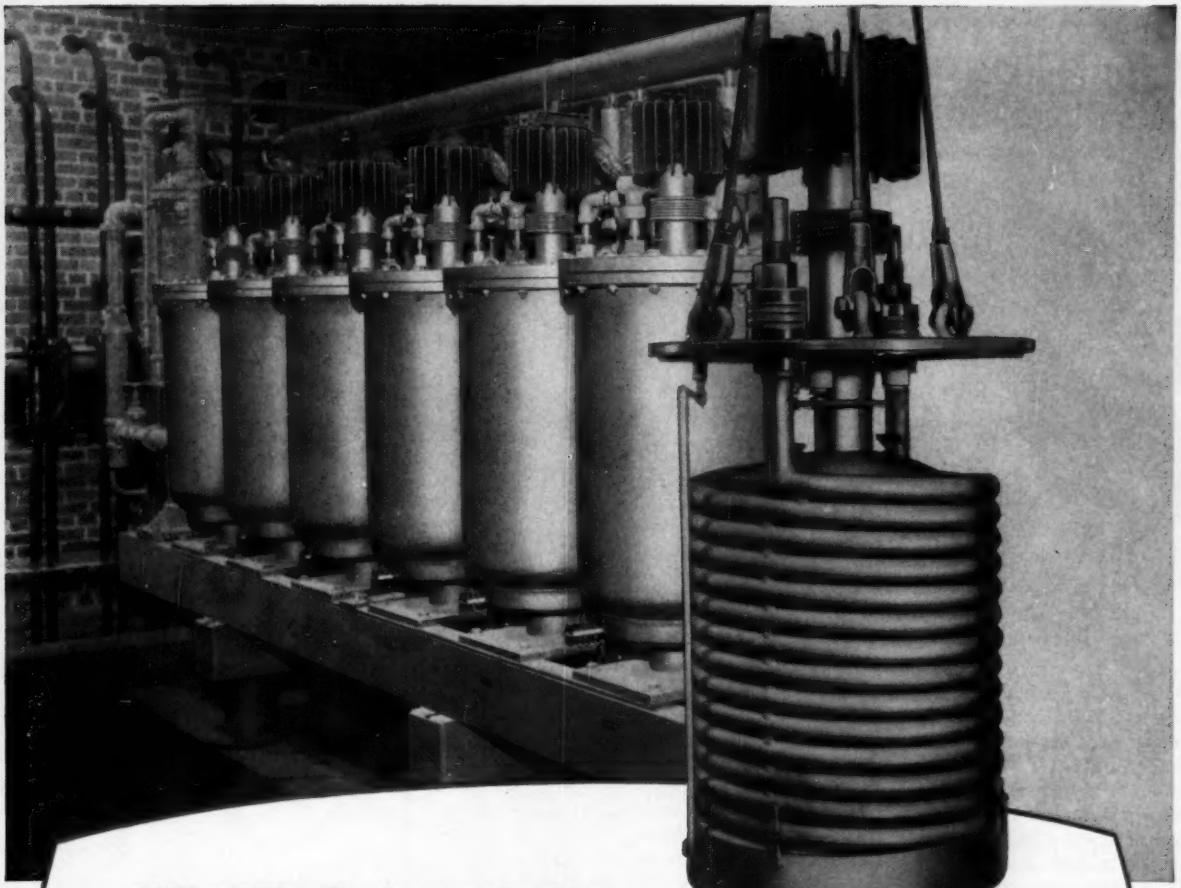


Air, hydraulic control valves

815 • Valve chambers of these valves are formed by aluminum spacers held in accurate metal to metal end abutment. This permits O-rings or U-packers to be supported on both inside and outside diameters without placing mechanical pressure on packers. Except for operating mechanism, plunger is only moving part. Request details.

C B Hunt & Son, Inc, Salem, Ohio

For more data on these items, use post cards on page 171. Identify your request with item number.



Why Allis-Chalmers Cooling Coil Design Means . . .

Better Rectifier Operation

More Efficient Heat Transfer results from internal cooling coil. The steel coil surrounds active parts, offering more cooling surface and better heat transfer than other types. Unit maintains more uniform temperature and mercury vapor pressure.

Simplified Maintenance results from Allis-Chalmers unique unit construction. All active components are attached to the anode plate for easy withdrawal, dismantling, and re-assembling — as illustrated above.

Positive Arc Barrier is formed by the cooling coil, which is insulated from the tank. The main arc is confined within the coil, preventing arc transfer to the tank.

Years of Operation in hundreds of installations have proved the reliability, ease of operation, and simplified maintenance of Allis-Chalmers mercury arc rectifiers. You can get complete information at your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

LIVE BETTER ELECTRICALLY

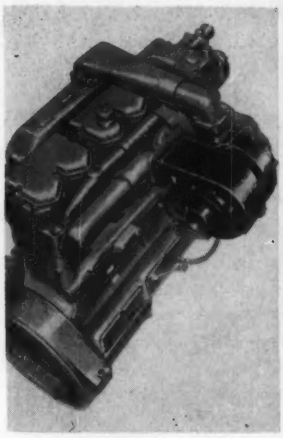
ALLIS-CHALMERS

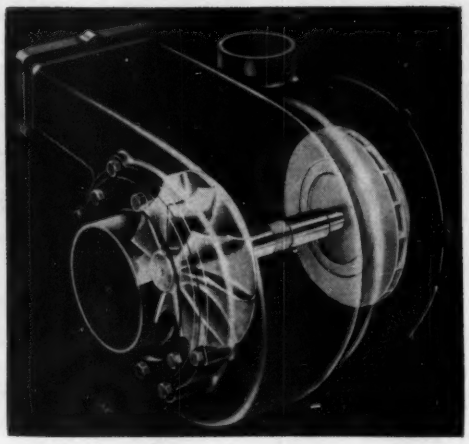
A-C ALLIS-CHALMERS

A-5084

More EQUIPMENT NEWS

Begins on page 162





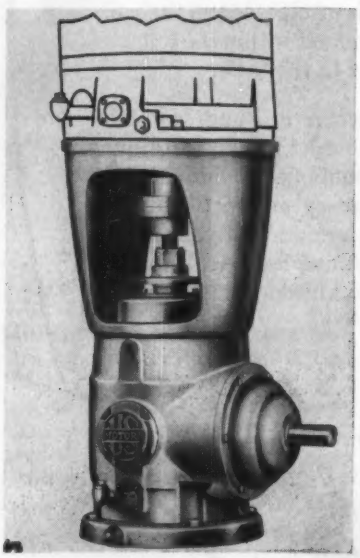
Turbocharged diesel engine is rated at 335 hp

816 • New *Turbodiesel* engine develops its 335 hp at 2100 rpm with a 90-F intake air temperature from 0 to 4000 ft. It is a 6-cyl, 4-cycle engine with a bore and stroke of 5⅛x6 in. and piston displacement of 743 cu in. Compression ratio is 14.5 to 1.

Key to high horsepower is the exhaust gas turbocharger. Here, normally wasted energy of exhaust gas is used to create power. This is done by piping exhaust through a turbine which is one element of the turbocharger. The exhaust gas is directed against turbine's blades causing wheel to rotate at high speed. A centrifugal impeller, mounted on the same shaft, but in a separate housing, draws fresh air and blows it into the intake manifold and cylinders under pressure. More weight of fresh air is forced into cylinders and a greater quantity of fuel can be burned completely—creating more power at the flywheel.

According to manufacturer, compared to a naturally aspirated engine of the same cu in. displacement, the *Turbodiesel* develops 67½ percent more power. Likewise, it produces 11½ percent more power than a mechanically supercharged unit of the same cu in. displacement. Fuel rate is claimed to be lower than naturally aspirated or mechanically supercharged engines.

Cummins Engine Company, Inc, Columbus, Indiana



Combination drive offers continuous pumping service

817 • Right-angle combination drive has been developed for municipal water supply stations, sewage disposal plants, fire fighting stations and other installations where continuous or standby pumping service is essential. Sizes range from 30 to 150 hp and are available in a wide selection of gear ratios.

In normal operaton an electric motor mounted on the disengaged drive powers the pump. In event of power failure or electric motor breakdown, the drive is engaged to transmit power from a standby combustion engine with very little lost time under emergency conditions. Details from manufacturer.

U.S. Electrical Motors, Inc, Box 2058, Terminal Annex, Los Angeles 54, Calif.

Atomic radiation detector

818 • Lightweight instrument is designed to detect and measure potentially hazardous atomic radiation. Called the *Radiameter*, the unit weighs only 2 lb, fits into a suitcoat pocket and operates on an ordinary flashlight battery. Request complete details from manufacturer.

Electronics Division, Curtis-Wright Corp, Carlstadt, N. J.

Distribution panelboard

819 • System offers both audible and visible warning for abnormal process functions. It works over a 2-wire pair or single wire and ground return up to several miles and produces a blast audible for more than 2500 ft. Any condition that will operate a switch or relay will trigger the alarm.

Sparton Control Systems Div, The Sparks-Withington Co, Jackson, Mich.

Distribution panelboard

820 • Heavy-duty power distribution panelboard incorporates rigidly-mounted fusible switch units of the quick-make, quick-break type. It is designed for 600-volt ac maximum service, 2- or 3-wire single-phase and 3- or 4-wire 3-phase applications. Known as the *Type QMR*, it can be safely operated in systems having short-circuit capacities up to 100,000 amps RMS asymmetrical when current-limiting fuses are used.

The units are of modular construction to permit ready interchangeability and can be provided in ratings of 30 to 200 amps, 2- and 3-pole construction. Units are horsepower rated for both standard and time delay fuses. Details on request.

General Electric Company, Plainville, Connecticut

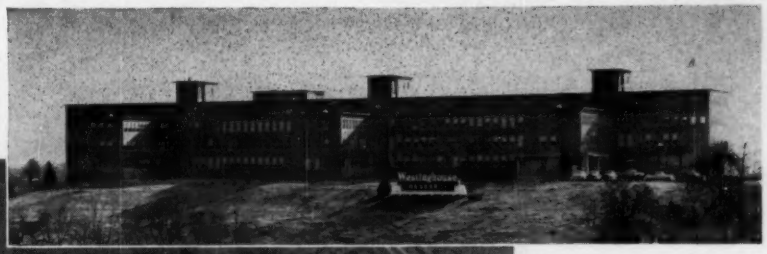
For details on these items use post cards p 171. Identify request with item number.

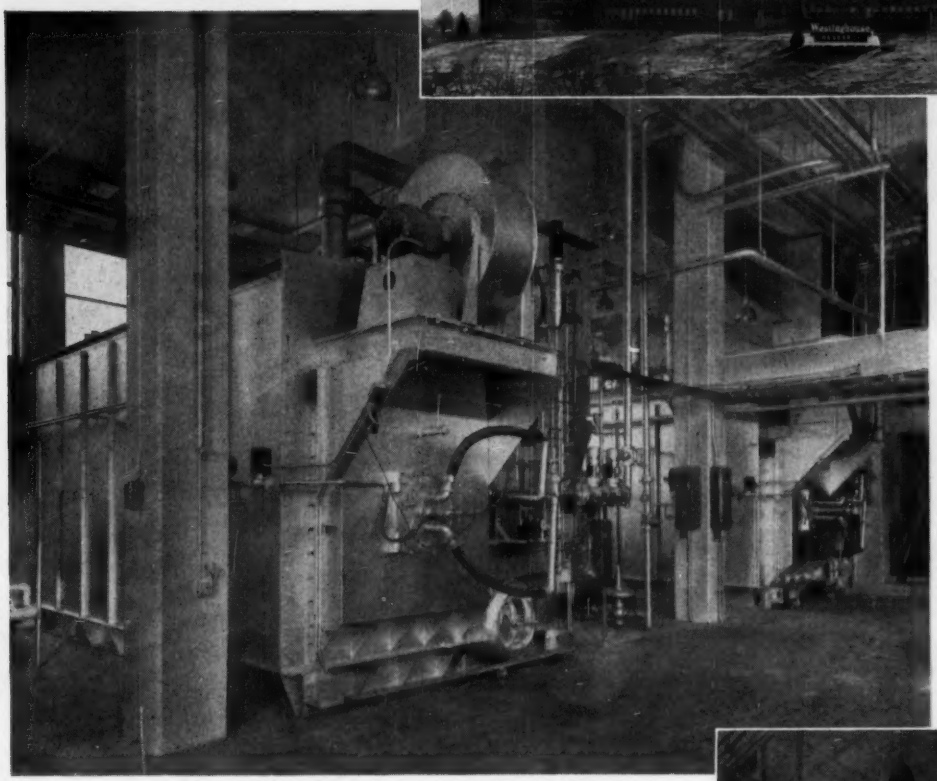
Check these too...

Magnetic air breakers ..... p 176
Double-roll grinder ..... p 176
Hydrazine comparator ..... p 178
Corrosion-resistant liquid end p 178
Condenser tube cleaning tool .. p 180
Rapid scale disintegrator ..... p 180

TWO NEW KEELER TYPE D-K PACKAGE BOILERS SERVE NEW WESTINGHOUSE RESEARCH LAB

Westinghouse Research Laboratory
Churchill Boro, Pittsburgh, Pa.

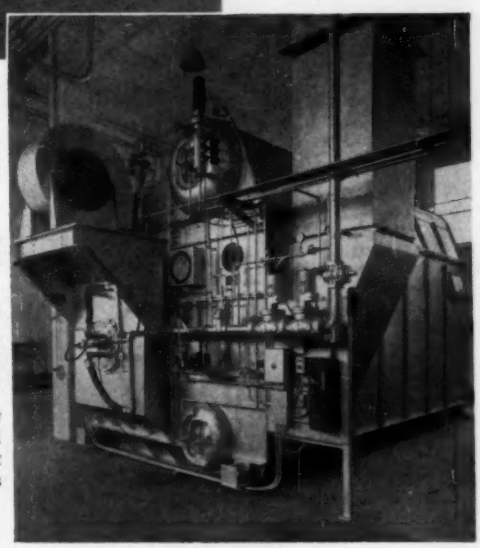




KEELER

Type DK

Newest member of the Keeler line—a compact, low-cost package steam generator (oil or gas fired) for limited space requirements.



Westinghouse Electric Corporation has selected two Keeler D-K Package Steam Generators to supply their modern new research laboratory with low cost steam for process and heat requirements. Keeler Boilers of various types and sizes are serving Westinghouse plants throughout the country and their efficiency, economy and dependability led to the purchase of the two D-K units pictured here.

Each of the new Keeler Type D-K Boilers shown are capable of generating 20,000 lbs. of steam per hour. The complete "package" includes all burning equipment, controls, safety devices and accessories for gas fired operation.

The Type D-K is made in oil or gas fired units with capacities from 8,000 to 45,000 lbs. of steam per hour, standard design pressure of 200 psi and a maximum design pressure of 325 psi. The D-K is specifically designed for use in power plants which will not accommodate long boilers of other types.

It incorporates the proven efficiency and economy of Keeler Water Tube Steam Generators in a new, compact design—a comparatively wide and short boiler that's completely steel encased and insulated, ready for quick hook-up and operation. Write or phone for complete information on this compact, new Package Power Plant!

The Seal of Quality in Water Tube Boilers

Write For Bulletins

No. DK-1: Type DK Package Boilers
No. F-14: Type CP Package Boilers
No. M-2A: Type CPM Package Boilers
No. MK-1: Type MK Boilers

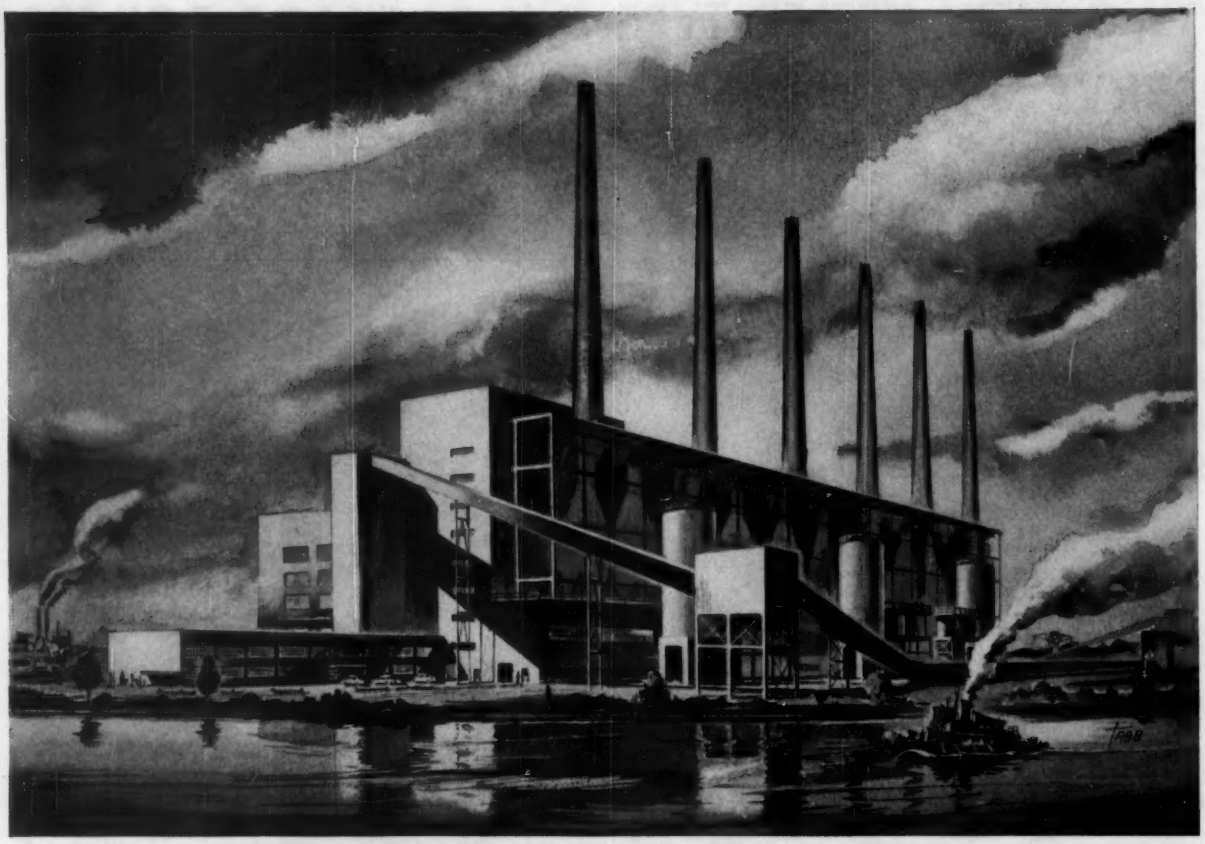
KEELER WATER TUBE *Boilers*

— ESTABLISHED 1864 —

E. KEELER CO.

200-300 West St. • WILLIAMSPORT, PA.

— OFFICES IN PRINCIPAL CITIES —



KEY-KAST Tee's and Ell's serve hot reheat lines at new Detroit Edison Power Plant

One of the three generating units of the new, modern River Rouge Plant of the Detroit Edison Company uses KEY-KAST Alloy Steel Welding Fittings. Hot reheat line to the turbine of this unit is fitted with KEY-KAST Tee's and 90° Ell Welding Fittings.

The high strength and long service life of KEY-KAST Alloy Steel Welding Fittings are a result of:

1. Heavy wall thickness throughout (at 27½" O.D., wall thickness is 1½").
2. Extra wall thickness at critical points to compensate for erosion.
3. Rigid dimensional and metallurgical control.

More and more power plants throughout the nation are specifying KEY-KAST fittings for their alloy piping needs.

And more and more engineers designing power plant installations are writing KEY-KAST into their specifications as a result of:

1. Desirable physical characteristics.
2. Wide variety of alloys immediately available.
3. Important cost advantages.

JOB DETAILS

Tube Size:
27½" O.D.

Material:
1¼% chrome
½% moly.

Pressure temperature:
750 psi @ 1010°F.

Fabricator:
Dravo Corp.
Marietta, Ohio

W-K-M MANUFACTURING COMPANY, INC.
A SUBSIDIARY OF acf INDUSTRIES INCORPORATED
PLANT: MISSOURI CITY, TEXAS • MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

For full specifications in the complete KEY-KAST line, write for Bulletin K.S. 1-52.

MANUFACTURING

KEY RETURN BENDS AND FITTINGS

W-K-M THROUGH-CONDUIT GATE VALVES

acf LUBRICATED PLUG VALVES

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AIR CONDITIONING, VENTILATING, REFRIGERATION AND HEATING

★ **Hermetic centrifugal units** designed to provide chilled water for air conditioning and refrigeration applications are described in bulletin DS-399. Contains capacity tables, water pressure drop charts, engineering data. ★Request direct on company letterhead from The Trane Co, La Crosse, Wis.

1 **Roof ventilators.** Sizes, specs, performance data, dimensional drawings are given in 16-p bulletin A-112A. Hartzell Propeller Fan Co, Piqua, Ohio.

2 **Refrigerating machines.** Hermetic centrifugal cooling units with pushbutton operation are discussed in 20-p bulletin 19C-100. Unit produces in 90 to 350 ton capacities. Carrier Corp, Syracuse 1, N. Y.

3 **Refrigeration insulation.** Illustrated 4-p bulletin emphasizes incombustible qualities, sanitary qualities, high-moisture resistance, low conductivity, high structural strength of this insulation. Johns-Manville, 22 E 40th St, New York 16, N. Y.

4 **Lubrication** of air conditioning and refrigeration equipment is discussed in 2-part bulletin 43. Part One tells what to look for in a refrigeration oil and how to determine oil needs of a refrigeration compressor. Part Two is an illustrated article explaining refrigeration principles and describing modern air-conditioning and refrigeration equipment. Sun Oil Co, 1608 Walnut St, Philadelphia 3, Pa.

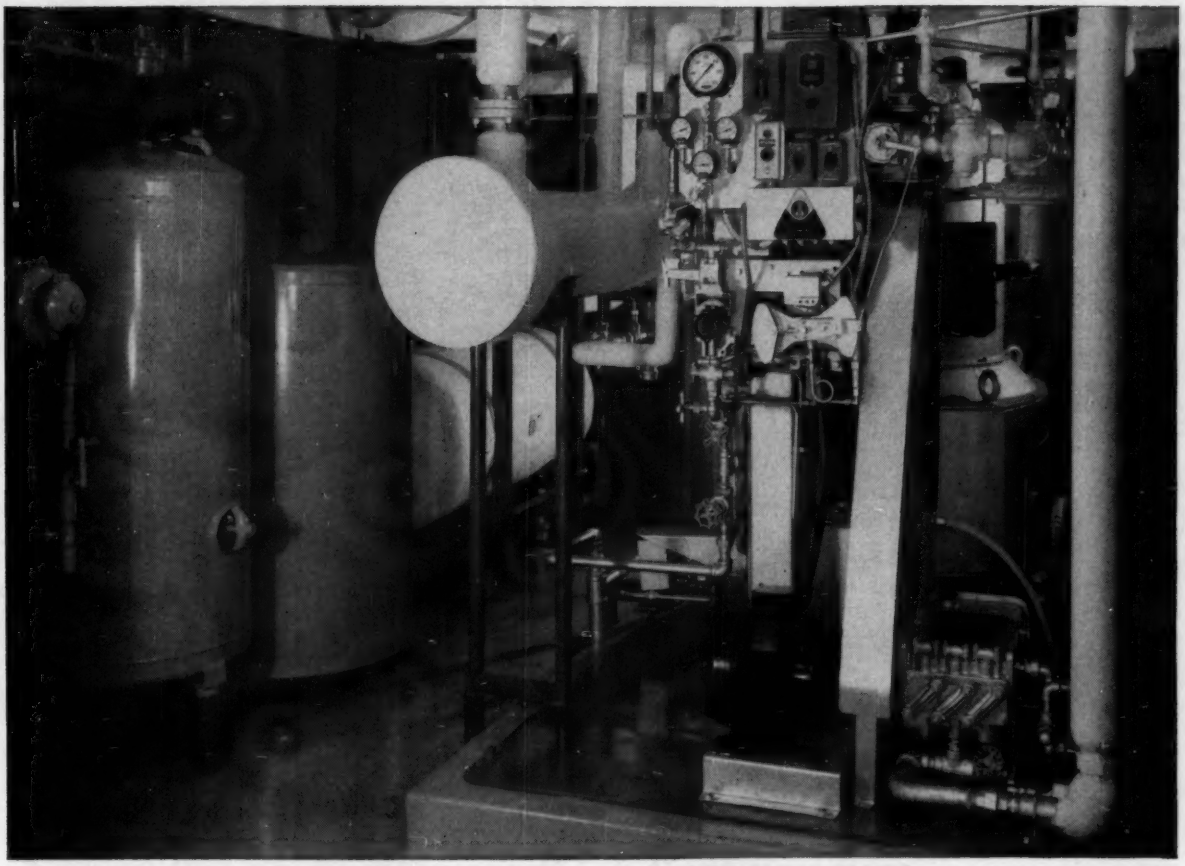
5 **Unit heaters.** Improvements, specs, performance data for horizontal and vertical units are presented in 36-p bulletin 700A. Includes descriptions of cabinets, elements, motor mountings, fans, controls, piping diagrams and other technical data. American Air Filter Co, Inc, 215 Central Ave, Louisville, Ky.

BOILERS AND AUXILIARIES

6 **Water-tube steam generators.** Bulletins 55-2 and 56-1 give complete data on *type-S* boilers and *type-A* shop-assembled boilers. Each includes descriptive material, photos and several separate data sheets of engineering drawings and technical information. Wickes Boiler Co, Saginaw, Mich.

7 **"Carbon products** for cupola furnaces" is title of catalog S-5450. Descriptions of well zone linings, breast and tap hole constructions, slag dams, and slag and iron trough linings relate the properties of carbon to these specific refractory problems. National Carbon Co, Dept E, 30 E 42nd St, New York 17, N. Y.

(*Continued on page* 218)



100 b.h.p. Modulātic at Fearn Food Products, Los Angeles. Floor area, only 5' x 7'-3". Floor load, just 150 lbs./sq. ft.

Beautiful!.. in appearance, performance

MODULĀTIC STEAM GENERATOR

— world's most compact power-package

This good-looking Modulātic installation shows how clean and uncluttered, how efficiently functional *your* steam generator space can be.

"Boilerhouse?" No! Modulātic needs no expensive enclosure, foundation, stack—takes no more room than a desk and chair. Any aisle or unused corner *anywhere* —basement, balcony, roof—is all the space you need.

Shipped fully assembled—just connect and fire up . . . equally easy to move. Passes through plant-type doorways. Can't waste fuel or water because steam is made only "on demand" to maintain the pressure you want.

As your main steam source or added capacity for power, processing, heating . . . for emergency service or conventional purposes . . . for permanent installation or mobility . . . there's nothing like Modulātic. Proved by more than 10,000 (now 13,000) in use.

Full steam in two minutes from cold starts ends early reporting and standby. Quiet, pushbutton operation. Eight sizes: 10 to 160 b.h.p. Pressures from 5 to 285 p.s.i., and *much more*. Oil, gas, or combination burner. Single or multiple units. *In Canada, write Vapor Car Heating Co. of Canada, Ltd., 65 Dalhousie Street, Montreal 3, Que.*

50 years of steam generation and controls

VAPOR HEATING CORPORATION
80 E. Jackson Blvd., Chicago 4, Ill., Dept. H-1

Please send me free 12-page Modulātic Booklet No. 586. I use steam for_____

Name_____

Company_____

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George Edwards

says you can't get there without a road map

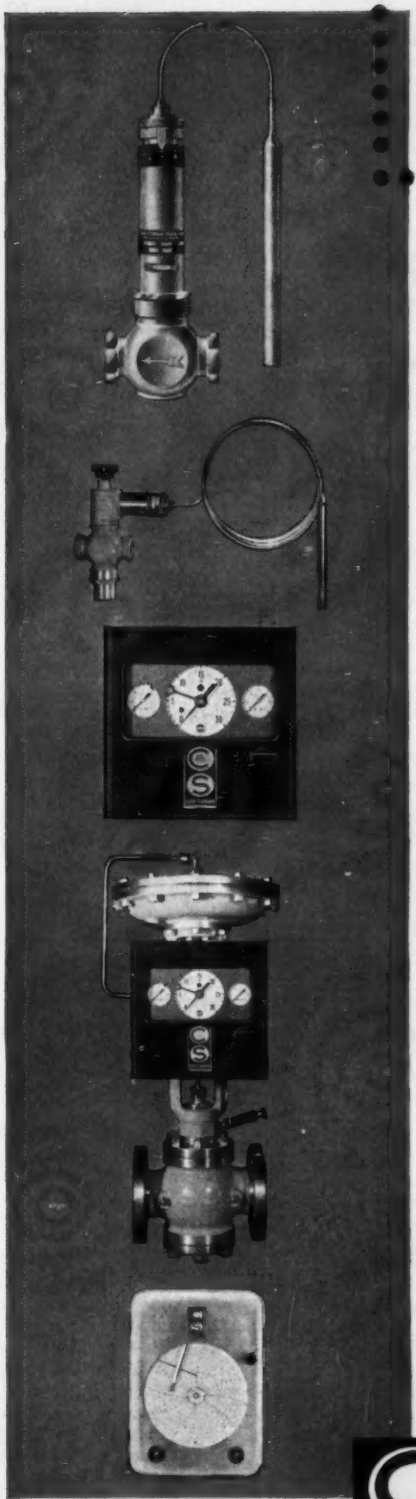
► SEVERAL YEARS AGO I took Mrs Edwards and the children on a grand tour of our great Western States. We had planned the trip all one winter, selecting interesting spots to visit and poring over road maps. As we had four weeks' time we worked out every detail carefully so our trip would pay the biggest dividend for the time and money spent. Our schedule was worked out as well as any railroad timetable.

After visiting Yellowstone National Park, we headed for Seattle and Mount Rainier. From there we hit Highway 99 to Portland, San Francisco, Los Angeles and San Diego. Along the way we took in many interesting sights. These included our great Douglas fir forests, dams and the giant sequoia trees. Coming home we drove through the desert and visited several Indian reservations, as well as the petrified forest. All in all, it was a most memorable and successful vacation as we saw everything we had planned. But that trip brings up a disturbing question. And if any of you readers can give me a logical answer, I'll be mighty thankful.

Why don't we plan for our future success as carefully as we plan a vacation trip? The Lord knows we run into some mighty rough detours even with the best maps. Yet none of us would start out on the first highway we come to—drive until we run into another, etc. If we did, we might end up at Cape Horn. Yet, as youngsters, we often flit from job to job without a definite plan—wondering in later years why we find ourselves in some impossible, outlandish place.

You younger plant men should prepare a road map of your future. If your destination is a plant engineer's desk, sit down with an older engineer and learn how he got there. The job calls for some basic knowledge. But there are many ways you can acquire that learning. It might be done by burning the midnight oil, taking correspondence courses, serving an apprenticeship or attending technical school while working at the right jobs. But you'll get much nearer your goal if you plan a road map and try to follow it. If not, don't be surprised to find yourself at Cape Horn later on in life. And you can take it from my neighbor, ex-sailor Hal Lawson, that's one desolate spot you won't like.

Sure, you can't expect all your plans to work out as well as our vacation trip. But you'll come much nearer if you know where you're headed. You'll have to detour along the way—even with the best road map—but your goal will still be clearly spelled out for you. And don't forget the timetable. Any old-timer will tell you the sand keeps running down until before long there isn't any left.



For Accurate, Reliable Temperature Control

STACON V SERIES
Self Operating Temperature Regulators—

Feature a liquid filled thermal system for high operating power and uniform throttling action and has built-in over-load protection. Available in 50°F. and 100°F. ranges from 25° to 325°F. Direct and reverse acting units ¼" to 1½" with screwed ends, and 2" to 4" with flanged ends. Bulletin No. 500. (Cash Standard Stacon Corp.)

STACON TYPE VS
Temperature Safety Regulators—

Used in the supply steam or gas line and will protect a process by snapping shut when the process temperature goes above a desired temperature level. Easily adjustable and remains closed until manually reset. Available in sizes from ½" to 1½" with screwed ends. (Cash Standard Stacon Corp.)

CASH STANDARD TYPE 51
Indicating Controllers—

An air operated, mercury actuated proportional temperature controller. Temperature ranges from —40°F. to 1000°F. Calibrated set point adjustment, unit construction, air relay with sapphire orifice and push button cleaner, feedback type proportional control with 1-100% band and differential gap. Also available with 1-150% proportional band combined with automatic reset action. Bulletin No. 978. (A. W. Cash Co.)

CASH STANDARD TYPE 30
Diaphragm Control Valve (With Type 51 Mounted)

A rugged, dependable control valve—available in sizes ½" to 12" with various styles of inner valves—reverse or direct acting. Accurate control is assured when the Type 30 is used with 51 or 57 controllers, valve mounted as illustrated, or where the controller is installed remotely. Bulletin No. 980. (A. W. Cash Co.)

CASH STANDARD TYPE 57
Recording Controllers—

An air operated temperature controller with mercury, vapor, gas or organic liquid actuation. Temperature ranges from —350°F. to 1200°F. Available in 9" and 12" case size, spring or electric driven chart drive, on-off control or 1-100% proportional control.

All units have push button nozzle cleaner; proportional controllers also have sapphire jewelled relay orifice with push button cleaner. Bulletin No. 979. (A. W. Cash Co.)

WHAT'S *YOUR* TEMPERATURE CONTROL PROBLEM?

Cash Standard and Stacon have the answer or will find one.

Contact the Cash Standard temperature and pressure control specialist in your area, or write Dept. E

CASH **STANDARD**

A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.
P. O. Box 551, Decatur, Ill.

PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

The Power Drive That Gives You Everything!

Really Portable—Lightweight, legs and tray fold in snugly, handy handle for carrying.

Easily Quickly Set Up—Built-in folding tray and legs open up for business instantly—all one unit, no loose parts.

Extra Rigidity—Open tray holds legs in strong, solidly rigid stance, adds strength. No front leg to obstruct swing of die stock handles.

Fast Easy Speed Chucking—Guaranteed grip, forward and reverse—no slip, even with geared tools. Replaceable insert jaws for long service.

Extra Power—Motor has larger long-life brushes, longer commutator, won't bog down under extra load.

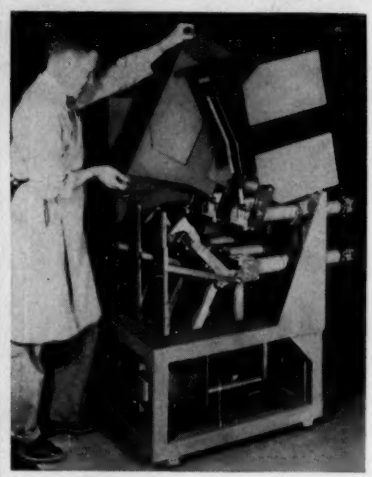
You can't beat it for performance, easy work and durability. Buy it at your Supply House . . . much the most for your money!

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U.S.A.

More EQUIPMENT NEWS

Begins on page 162



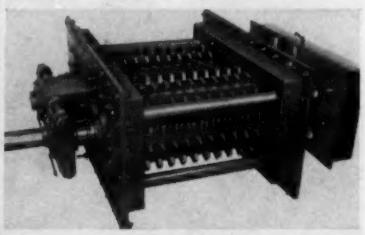
Magnetic air breakers

823 • New 5- and 15-kv magnetic air circuit breakers extend company's line through 250 and 500 mva interrupting capacity.

The *DST5-250* breaker is a horizontal drawout device for use in metal-clad switchgear. Special design features include (1) arc chutes that can be tilted back for contact inspection (2) high-capacity "puffer" system to assist arc blowout on low-current operations (3) fast, dependable solenoid operation (4) specially designed racking-in mechanism to facilitate breaker insertion and withdrawal from the cell. Full details from manufacturer.

Federal Pacific Electric Co,
40 Paris St, Newark 1, N. J.

For more details on these items, use post cards p 171. Identify your request with item number.



Double-roll grinder

824 • Sump-type double-roll grinder is used for sizing solid materials conveyed in materials-handling systems. It is designed for heavy-duty loads and for installation in a sump, located either below or above floor level. Photo above shows the grinder assembly without housing.

Grinder rolls are of manganese steel. Teeth are integrally cast and individual ones can be replaced, when worn, by being burned off and new ones welded in their place.

The grinder handles either wet or dry material and can be operated with its rolls submerged. Damage from water, grit or dust is eliminated by mounting bearings outside the shaft stuffing boxes and protecting them with lantern rings in the

We say this without reservation—will back it up with proof:

New Balanced Mobil D.T.E. Oils Can Improve Your Production And Reduce Manufacturing Costs

For years Mobil D.T.E. oils have set the standard of quality for all hydraulic and circulating oils. Recently they were dramatically improved—so much so that their margin of superiority is now greatly increased.

New Mobil D.T.E. oils are *balanced* to meet the widest range of operating conditions. They will give years of trouble-free service—even in continuous high temperature circulating systems. They will keep your machines free from deposits over the complete range of service. They will give you the highest degree of protection against wear...rust...corrosion. In fact, tests show *most machines will become obsolete before these oils need changing* when operating at normal temperatures.

Let us show you concrete *proof* that new balanced Mobil D.T.E. oils can improve production and cut manufacturing costs. Ask your Mobil representative for the "balanced" story.

SOCONY MOBIL

FIRST STEP IN CUTTING COSTS

SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

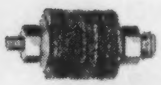
An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.

Expanding brush and replaceable element.



Sectional wire brush.

Air valve for one-man operation.

ROTOJET®

Junior TUBE CLEANERS

ELLIOTT COMPANY - ROTO DIVISION

Tube Cleaner Specialists Since 1910

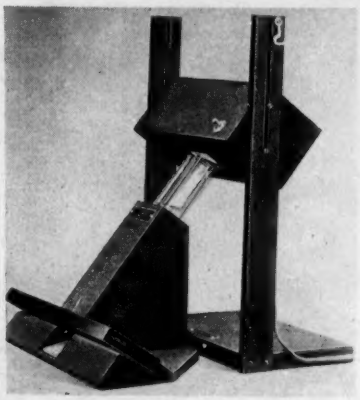
153 Sussex Avenue, Newark, N. J.

More EQUIPMENT NEWS

Begins on page 162

stuffing boxes. When dry materials are handled, compressed air is passed through the lanterns to prevent entrance of grit into bearings and packing rings. With wet material, water is used for purging.

The Allen-Sherman-Hoff Co, 259 E Lancaster Ave, Wynnewood, Pa.



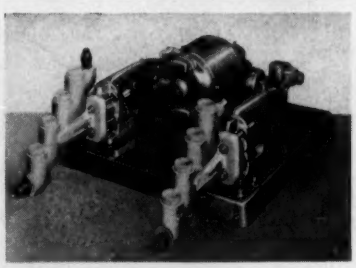
Hydrazine comparator

825 • Instrument provides a method of analysis when hydrazine is used as an oxygen scavenger in industrial boilers. The unit is a water analyzer with a slide containing permanent hydrazine standards for the values, 0.00, 0.02, 0.04, 0.06, 0.08, 0.10, 0.15, 0.20 and 0.30 ppm hydrazine.

A test is made by placing 50 ml of the sample in a 2-oz glass-stoppered bottle with minimum exposure to air and adding 2.5 ml of hydrazine reagent. After mixing, sealed test sample is allowed to stand 30 minutes before reading. Previous to this time, two water analyzer tubes are filled to the mark with water being tested and placed in outside compartments of the base. Treated sample is transferred to the third tube (to the mark) and placed in middle compartment. Slide is moved as required and colors observed in mirror until a color match is obtained. The hydrazine value is read directly from the slide. Further data from manufacturer.

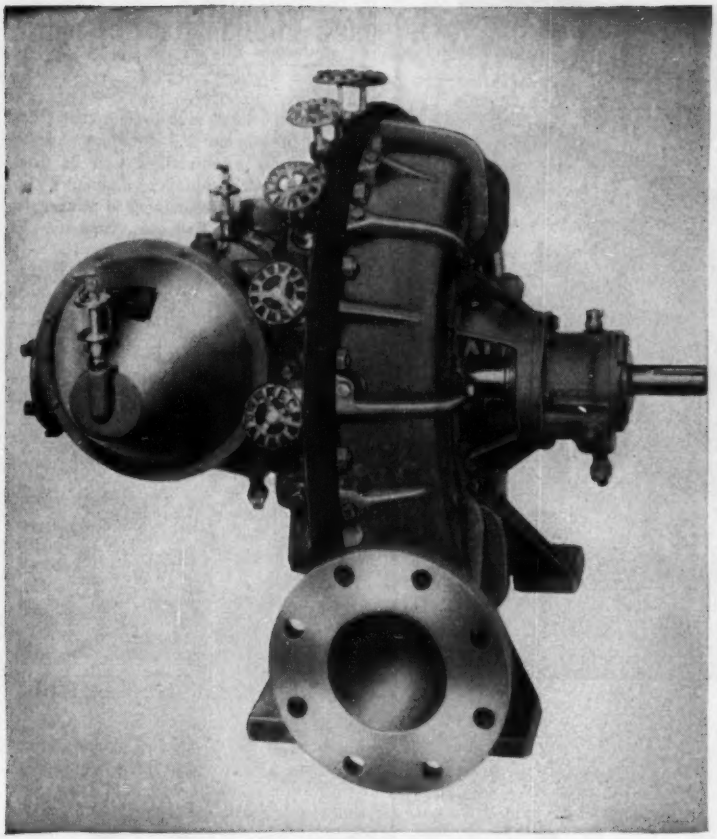
W A Taylor & Co, 7300 York Rd, Baltimore 4, Md.

For more details on these items, use post cards p 171. Identify your request with item number.

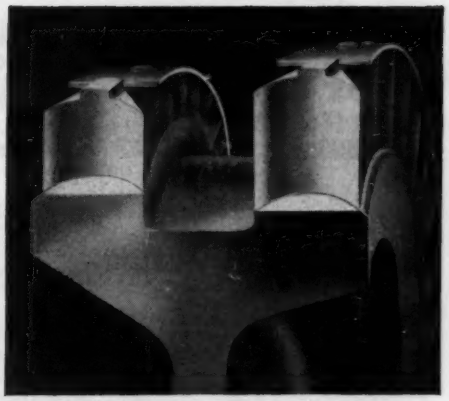


Corrosion-resistant liquid end

821 • Plastic material known as *Plio-Tuf* is being used for low-pressure, moderate-temperature applications where chemical being pumped would corrode metals



This is the reliable Coppus Turbine furnished with either type of wheel



Wide bucket "L" type wheel

Regular type wheel

Top performance in all COPPUS TURBINES

Both the regular type wheel or wide bucket "L" type wheel give you Coppus proven high quality and low maintenance cost. The "L" type wheel is the new development for use where low water rate is essential.

Coppus "Blue Ribbon Turbines" earned their fine reputation right on the job. Users vouch for their top quality performance and their low maintenance cost.

In the words of the supervisor of a large chemical company: "Coppus turbines require so little maintenance that a person would starve to death, if he depended on it for a living."

Proven features of *all* Coppus Turbines:

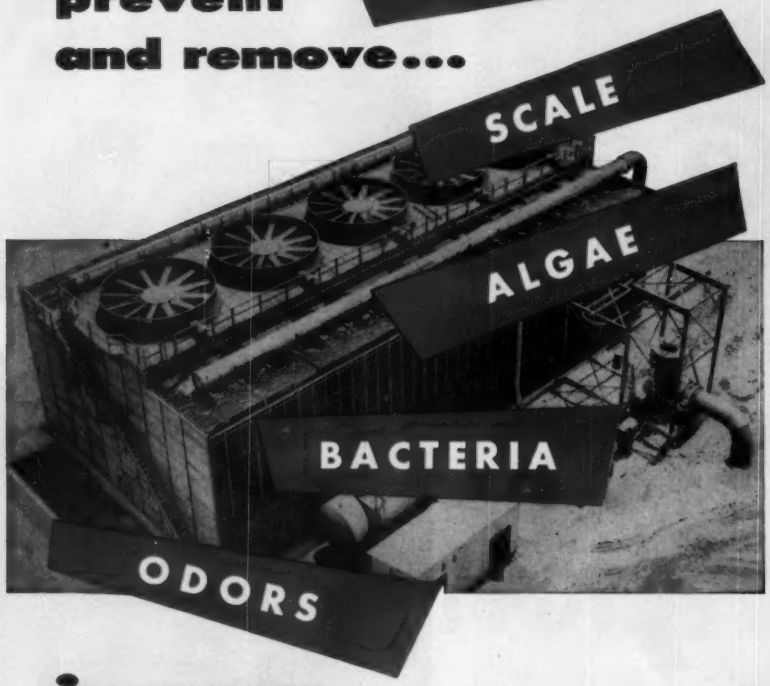
- Turbines rated close to your hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther*. Send for Bulletin 135 on Coppus Turbines.

COPPUS ENGINEERING CORPORATION
168 Park Avenue, Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

prevent CORROSION
and remove...



in your cooling system!
with
Custom-Formulated MEMPO Products

It may save you a lot of money to have a DEADY (say Dee-Dee) Corrosion Consultant study your cooling tower problems. There's sure to be a MEMPO product formulation and the right DEADY METHOD to treat your cooling water — to prevent the corrosion, scale, algae, bacteria and odors that inhibit the efficiency and operation of your cooling system.

MEMPO Products are a series of Metal Polyphosphate chemicals (crystals, powders or liquids) that are modified and/or formulated to meet your individual plant conditions. The exclusive DEADY METHOD is the only comprehensive system of control, through the use of these chemicals, to assure proper results.

The DEADY water treatment laboratories (Chemical and Engineering Specialists) — unequalled anywhere — can prescribe the MEMPO treatment for your problems. The treatment will be applied and periodically checked by a DEADY field engineer using the exclusive DEADY METHOD.

DEADY
Says: DEE-DEE

MEMPO Products have also been applied most successfully to evaporative condensers and industrial air conditioning systems. Complete details are available from

DEADY CHEMICAL COMPANY
Kansas City 1, Mo.
Los Angeles, Cal.

More EQUIPMENT NEWS

Begins on page 162

and alloys. Relatively low cost of this liquid end is partly due to fact that *Plio-Tuf* can be molded and does not have to be extensively machined. It can be used on pumps with plunger diameters up through 1⅛ in. Recommended ranges of use are: pressure, 150 psi; capacity, 70 ghp; temperature, 160 F.

Milton Roy Co, 1300 E Mermaid Lane, Philadelphia 18, Pa.

Condenser tube cleaning tool

826 • Unit reportedly uses a gun-and-slug method to thoroughly remove slime and scale at a considerable time savings over ordinary mechanical methods. One man can load an entire bank with cleaning slugs and shoot them through in rapid succession. The gun can be operated by either air or water pressure. Effective pressures range from 50 to 200 psi.

Three types of cleaning slugs in sizes to fit all standard tubes can be furnished. Spool-type slugs for normal slime removal are designed with a cup at the forward end that expands to wipe inside of the tube clean. Bullet-shaped slugs are for removing heavier or thick slime deposits. Scraper-type slugs cut away scale or mineral deposits as they are driven through the tube. The latter two types have "jet-action" holes in the sidewall to admit water or air for flushing away deposits as they are removed.

Crane Packing Co, Dept PRN, 6400 Oakton St, Morton Grove, Ill.

For more details on these items, use post cards p 171. Identify your request with item number.

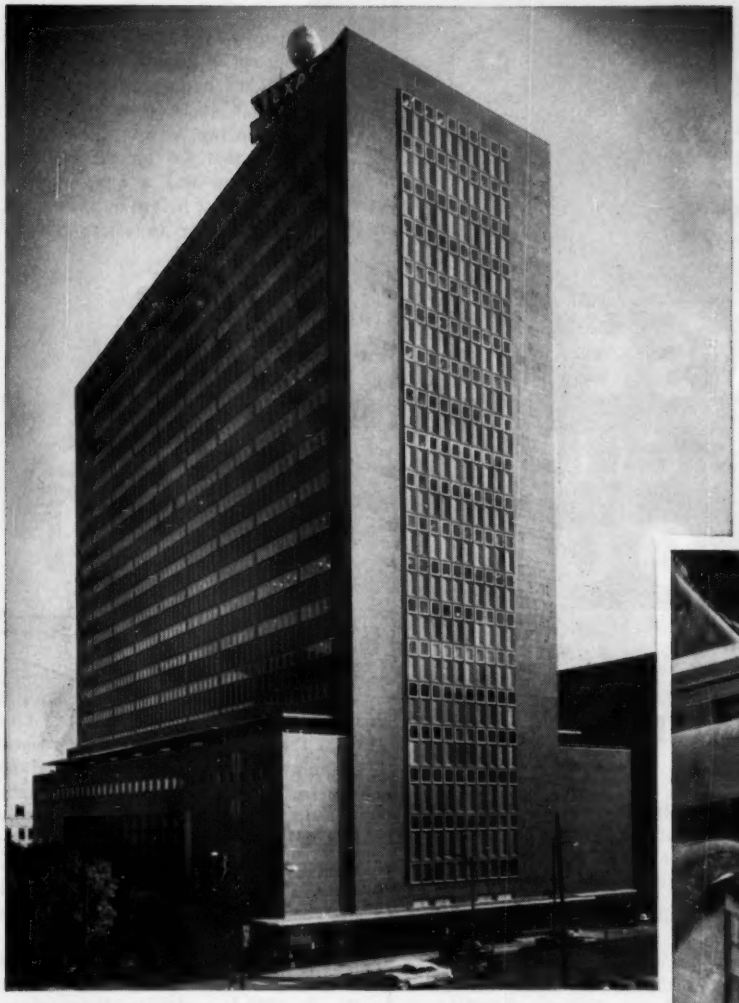
Rapid scale disintegrator

827 • Powdered scale disintegrator can be used in recirculating cooling water systems while they are in operation. It is suited for periodic cleaning of once-through systems and boilers and for removing water scale from heat-exchange surfaces. No special equipment is required—treatment can be applied by plant maintenance personnel. The powder contains a special inhibitor that reportedly prevents attack on any metals in the system. It requires no neutralizers and, after cleaning, the treatment solution can be safely drained by bleed, blowdown or overflow.

Alken-Murray Corporation, 131 E 23rd St, New York 10, N. Y.

NATIONAL SEAMLESS PIPE

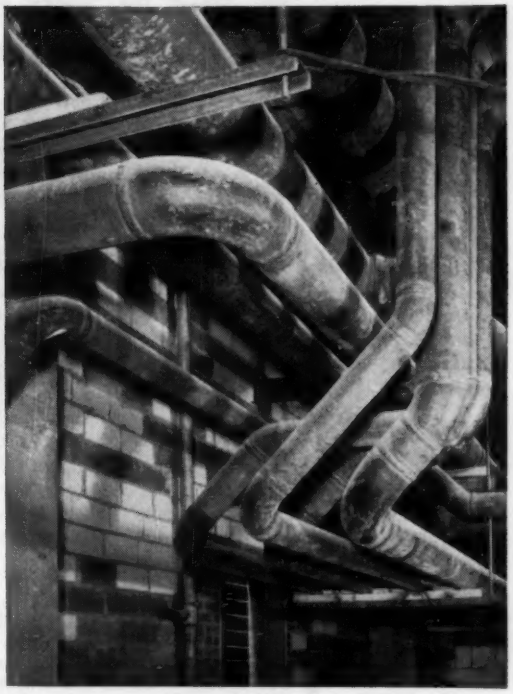
used for heating and air conditioning system of new Texas National Bank Building



USS National Seamless Pipe, in sizes from 4" O.D. to 16" O.D., was utilized in the heating and air conditioning system of this new Houston, Texas, building, owned jointly by Texas National Bank and Continental Oil Co., as follows:

Sizes 4", 6", 8", 10" and 12" are used for combination hot and chill water lines to the primary and zone conditioners as well as the perimeter units. The 16" O.D. pipe is used for handling condenser water.

The 14" O.D. pipe is part of the steam piping system which in turn converts the water into hot water for heating through the use of converters.



USS National Seamless Pipe is consistently the number one choice of engineers and contractors throughout the country for air conditioning, heating and power installations. Its ability to render efficient, trouble-free service under all types of pressure and temperature conditions has given National Seamless a reputation for safety and dependability excelled by no other pipe. For further information, or assistance with your pipe problems, get in touch with our engineers.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL Seamless PIPE AND TUBES

SEAMLESS WITHOUT WELDS

UNITED STATES STEEL

CONSECO
SAVES CLIENT
$25,000!

THE JOB:
TUBE SHEET REPAIRS
IN HIGH PRESSURE HEATER

The 3½" thick tube sheet was leaking badly. Our job was to remove old weld by drilling and burning, uncover and pierce 44 tube ends below tube sheet, apply 44 tapered steel plugs and replace weld. A previous unsuccessful repair attempt (not by CONSECO) had cost the client $18,000.

In 8½ working days, at a cost of only $4,000 three CONSECO men completed the work. Hydrostatic tests, using fluorescent dyes and black lights, plus circulating tests of 2500 lbs. of hot water pressure, proved everything satisfactory.

And our client saved the cost and delay of retubing, estimated at $25,000. *This shows what can be done by CONSECO SERVICE on any tubular equipment. Available anywhere . . . 24 hours a day, 7 days a week, Sundays, all holidays. 'Phone Maintenance Department.*

• *Send for Bulletins giving complete engineering data on these products.*

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HEAT EXCHANGERS • CONDENSERS • EVAPORATORS • STEAM JET AIR EJECTORS • STEAM GENERATORS • PRESSURE VESSELS CENTRIFUGES • FILTERS and STRAINERS • PUMPS, INSTRUMENTS, SPECIALTIES

12

CONDENSER SERVICE & ENGINEERING CO., INC. CONSECO
Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

164 Observer Highway
Hoboken, N. J.

MARMADUKE

Continued from page 150

gest trouble was that for a young engineer he was so bright he liked to show off. Fact is, Chuck never passed up a chance to gloat. But I felt he'd change in a few years after his feet were wet by experience. Old Stanley hated Chuck. But Chuck didn't hate anybody. He was smart and good-natured enough to be friendly with everyone. But he got a bang out of getting Stanley's goat —which didn't happen often. Fact is, the score was about even in the war between those two.

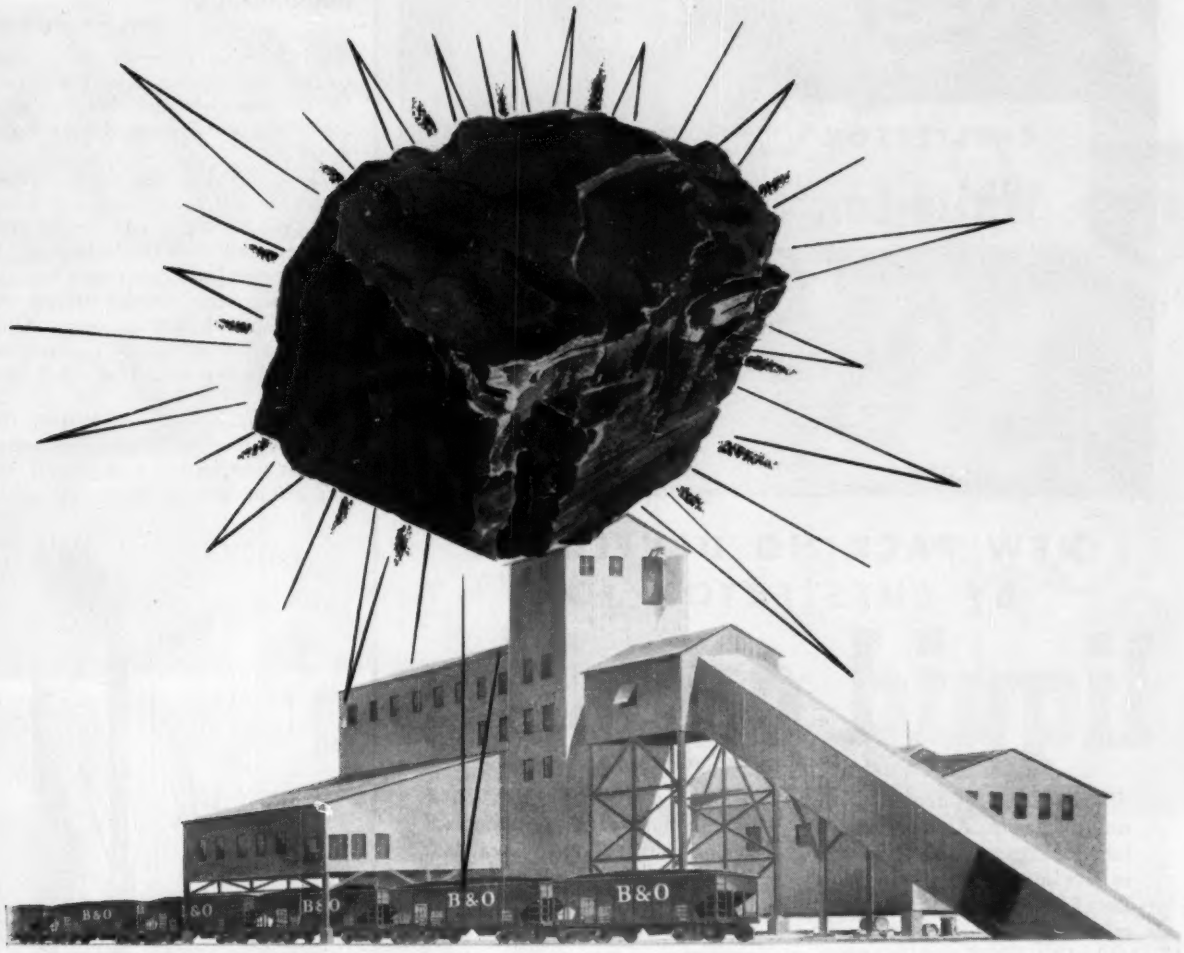
"The day that flat on the collector ring showed up was a busy one for Stanley. Then just before quitting time, Chuck barged over to where Stanley

was overhauling a fan bearing in the boiler room. Chuck slapped him on the back and in a friendly voice asked him to fix that flat after supper. That's when Stanley blew a gasket. We worked 10 hours a day in those days and thought nothing of a little overtime. But this was Tuesday night when one of the gang would have the poker game at his home. You'd think that Chuck caused that flat himself, just to get Stanley's goat.

"After Gullick popped his safeties and let off a little steam, he yelled after Chuck, 'Think you're so damn smart. I'll have that job fixed in a few minutes—I'll show you, wise guy!'

"After a cold supper Stanley turned to and rigged up the portable grinder. The grinder was driven by a small ¼-hp 220-v dc motor. It had a variable-series resistor and juice was supplied from a little steam-engine exciter set.

"Stanley really went into high gear. He knew Chuck would stick around until the unit was all set for next morning's operations, but he was plenty burned up. The slip ring was 10 inches in diameter and two inches across its face. Before long, Stanley had his portable grinder set in place on an old lathe cross-feed that he bolted to the alternator housing. Then he brought



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As population grows and living standards soar, the added energy requirements can easily be met by B&O Bituminous. In addition, its modern mining and utilization will assure greatest efficiency at stable, low cost. *Ask our man!*

LET OUR COAL TRAFFIC REPRESENTATIVE HELP YOU!
He will gladly suggest the perfect constant-low-cost Bituminous coal for your particular needs.
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BALTIMORE & OHIO RAILROAD

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liquid caustics

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Chesterton White-Lon is especially designed for an effective packing seal against all liquids of high pH value. White-Lon is the first packing designed solely for this extremely difficult condition. It is manufactured from chemically pure Chrysolite Canadian Asbestos. In our exclusive process, *each strand* of this fine yarn is immunized against caustic action by treatment with DuPont *Teflon* Suspensoid in the same exclusive manner as is our famous Blu-Lon acid packing.

White-Lon is ideal for stainless steel and chrome plated shafts. It is white in color, contains no graphite but has received a light breaking-in lubrication.

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A pH SCALE FOR CHEMICAL PACKINGS

1 TO 4	5 TO 10	11 TO 14
pH VALUES	pH VALUES	pH VALUES
STRONG ACIDS	WEAK ACIDS OR ALKALIES	STRONG ALKALIES
#320	#315	#322
Blu-Lon	Carsons	White-Lon

PACKING Chesterton SERVICE

A. W. CHESTERTON CO. • EVERETT 49, MASS.
America's Oldest Manufacturer of Mechanical Packings

MARMADUKE

Continued from page 182

the turbine up to speed and started feeding the grinder against the ring for the first light cut. But for some reason the wheel removed hardly any metal.

"That riled him because he wanted to get the hell out of there and to his card game. He tried varying the grinder speed, then the turbine speed. But that metal still didn't want to come off the slip ring. Stanley dressed the grinding wheel, but no soap. After cussing a blue streak, he changed the wheel for a new one. That didn't help either.

"The more things Stanley tried, the slower the progress he seemed to make. By that time he was raving mad. He was tearing around, trying one thing,

then another and cursing at the top of his voice, watching the clock ticking away past the deadline for the card game.

"About 8 pm, Chuck wandered leisurely into the shop, but he didn't stick around. Stanley's danger signals were flying and it didn't even take a smart man to know this was no time to ask questions.

"Finally 9 o'clock rolled around and Chuck stuck his head into the shop again. Gullick was still at it—he wouldn't give up—but Chuck saw the old boy was licked. Besides, he wanted to go home himself. Stanley was really sizzling. He could have drowned his own grandmother—fact is, he acted like it might be a pleasure to tackle any little project like that.

"Stanley was cursing the alternator manufacturer, the mill, his tools. Then when he saw Chuck standing at the door, he started cursing Chuck for good measure.

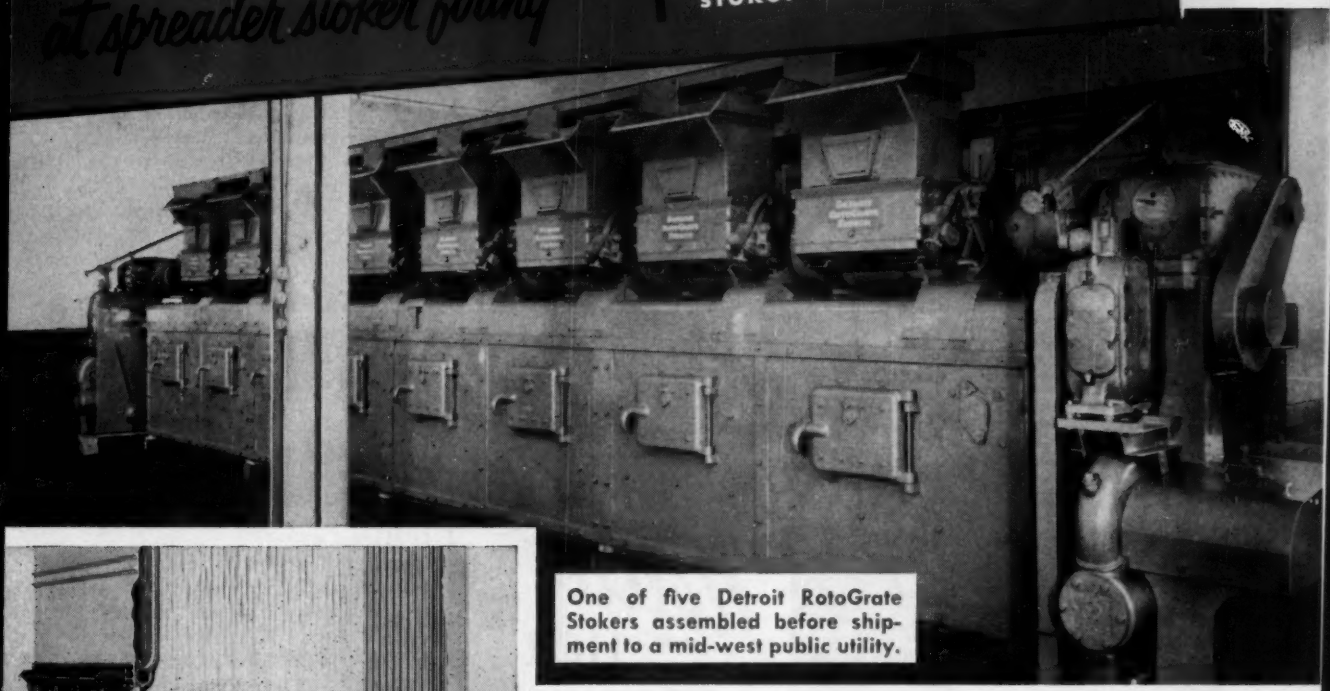
"At that point Chuck started walking slowly toward the alternator to investigate. Without stopping, he glanced

Let's take a NEW LOOK at spreader stoker firing

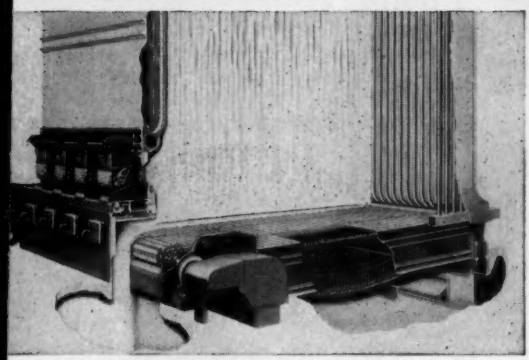
particularly

DETROIT ROTOGRATE

stoker advantages



One of five Detroit RotoGrate Stokers assembled before shipment to a mid-west public utility.



etroit RotoGrate Stoker with two of the six Rotors moved to show the overlapping highly restricted ate designed especially for spreader stoker firing.

Contact our nearest istrict Office or your consulting engineer.

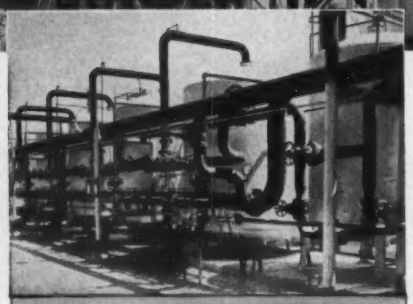
- **High Burning Rates** per square foot of grate area permit continuous operation with less expensive boiler and furnace design
- **Low Carbon Loss** results in high over-all efficiency
- **Superior Design** permits operation with low excess air
- **Wide Load Range** handled smokelessly with convertible grate area
- **Low Maintenance** compared to other coal-burning methods.
- **Burns All** bituminous coals and Lignite. Also bark, wood, bagasse and other refuse fuels, either separately or in combination with coal

Backed by over a half century of experience. Complete manufacturing and service facilities.

DETROIT STOKER COMPANY

General Motors Building — Detroit 2, Michigan

District Offices in Principal Cities • Works at Monroe, Michigan



Top photo shows new outdoor hot lime-zeolite softener installation in a Southern refinery. Five Nalcite HCR ion exchange units (lower photo) have output of 470,000 gallons of zero hardness water between regenerations.

with
Nalcite® (DOWEX*) HCR
HOT LIME
ZEOLITE
TREATMENT

Start with the simplicity of operation . . . add the low operating costs of hot lime-zeolite softening . . . all made possible by the outstanding high-temperature performance of Nalcite HCR in the zeolite softeners. Results: Zero hardness water, from virtually any raw water source, with a minimum of testing and control required. See your water treating equipment manufacturer for details on new or conversion hot lime-zeolite treatment for your plant . . . and for top softener efficiency, specify Nalcite HCR.

*Reg. Trademark of The Dow Chemical Company

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Nalco® PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

MARMADUKE

Continued from page 184

quickly at the grinder and said quietly over his shoulder in passing, 'Why don't you get your grinding wheel running in the opposite direction to your slip ring, Gullick? Isn't it kinda late to be playing games?' Then he scooted quietly through the door, whistling as happily as a lark.

"That did it. Stanley picked up his ball-peen hammer and heaved it after Chuck. It splintered the door with one helluva crash. Then he stopped the grinding wheel. Chuck was right. The wheel had been running in the same direction as the slip ring—and at about the same speed. But he had been so riled up all evening he couldn't see it. Stanley quickly reversed the grinder motor leads and by 10 o'clock the job was finished. But after that he treated book engineers, especially Chuck, with more respect."—*SME*

Marmy's Mailbox

IS MARMY WRONG?

Marmy is my idea of an outstanding engineer so I didn't expect to catch him in a mistake. Maybe I haven't—chances are the blame falls on Donald McGraw, Paul Montgomery, Shelton Fisher, Lou Rowley, Steve Elonka or anyone BUT Marmy.

In the September issue Marmy is going up the Ohio River from Cairo when he has trouble at Evansville, Ind. Then more trouble at Louisville. Next, he leaves Evansville. It seems he's towing empty barges aimlessly up and down the river or SOMEONE has made a mistake.

Did everyone who stopped in the Bent Propeller Bar last month have too much of their Sandpaper Gin?

R F GOBERT *Terre Haute, Ind.*

ED. NOTE: I wouldn't be surprised.

COFFEE BAD FOR MARMY

Marmy's story about the brewery smokestack is the best yet—except his jittery-turbine yarn. I hope Marmy continues to flourish for years to come. But I'm worried about his increasing tendency to hit the coffee pot instead of his bottle of Sandpaper Gin. Looks like he's getting senile or failing in health—as if his days in POWER are numbered.

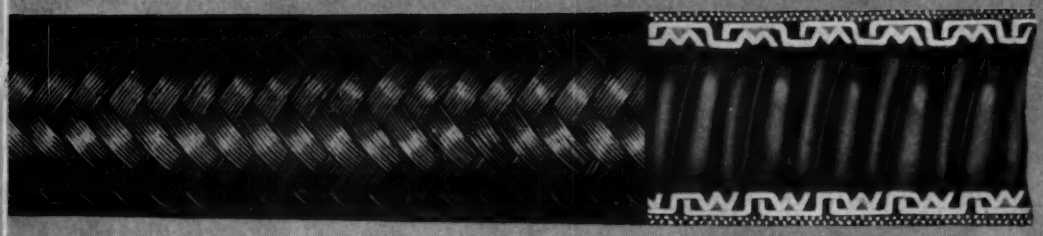
G C THORNTON *Englewood, N. J.*

HOW DO I GET ONE?

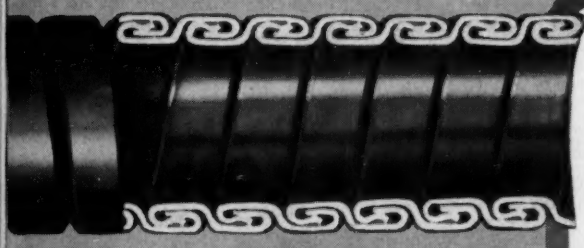
A whole book of Marmaduke stories and I didn't know about it. I must have been asleep. How do I get one?

R F DODGE *Hammond, Ind.*

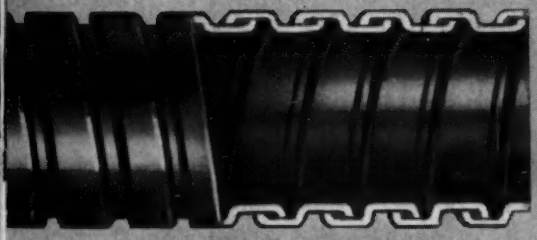
ED. NOTE: Just send $1 to POWER and you'll get a copy by return mail.



TYPE FP WIRE BRAIDED



HEAVY DUTY INTERLOCKED



LIGHTWEIGHT SQUARELOCKED
Unpacked, cord packed, light asbestos packed, heavy asbestos packed

TWIN-LOK
Galvanized Lined
Stainless Steel Lined

PENFLEX

FLEXIBILITY

DEFIES HEAT...FATIGUE ABRASION...LEAKAGE

Penflex is ruggedly built hose with all of the flexibility required, plus the toughness and durability of metal. No matter how hot the material to be conveyed Penflex cannot be cooked like ordinary hose. It stubbornly defies rough abuse, abrasion and crushing.

From 1/8" I.D. to 24" I.D. . . . bronze, galvanized steel, or stainless steel . . . from an air compressor line to a diesel exhaust, Penflex makes them all for the power industry. And Penflex "Flexineering"—the science of applying flexible tubing to fit the particular needs of the job to be done—assures the right tube in each installation. When you require tubing or hose that is tight as a pipe, but flexible . . . safe at high temperatures . . . and free from metal fatigue, specify Penflex.

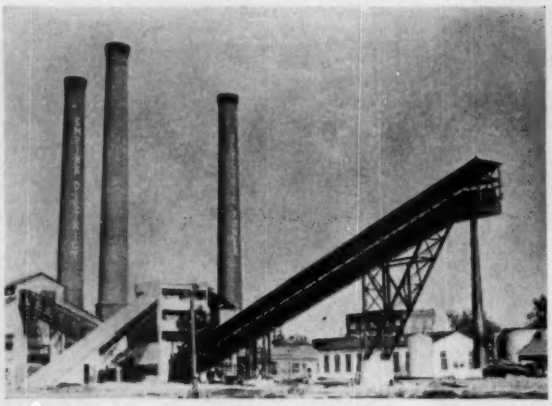
Penflex manufactures a complete line of four wall interlocked and seamless welded corrugated flexible tubing for the power industry. Write for your free copy of the booklet "Flexineering At Work."

Pennsylvania Flexible Metallic Tubing Company, Inc., 7237 Powers Lane, Phila. 42, Pa. *Branch Sales Offices:* Boston • New York • Chicago • Houston • Cleveland Los Angeles and Distributors in Principal Cities

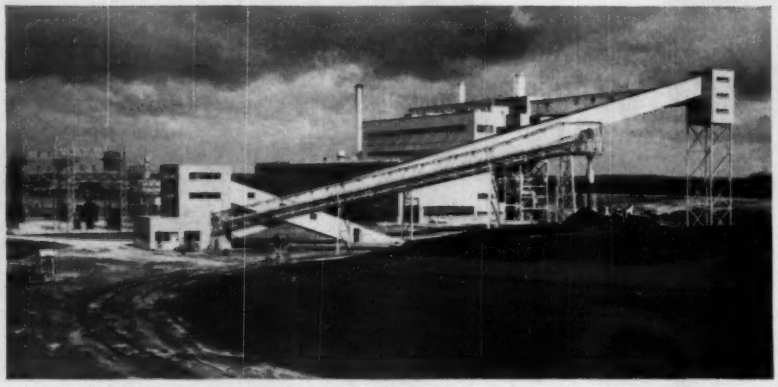
HEART OF INDUSTRYS LIFELINES

METALLIC TUBING

EARN EXTRA PROFITS IN SAVINGS



McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.



McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

—With Cost-Cutting

COAL-HANDLING SYSTEMS

Engineered for Your Plant

Are you paying "extra fare" luxury rates for that last ride your coal must take from the truck, car, or barge, to your bunkers?

Why pay more? Why risk breakdowns, when you can *save* extra "profits" and be sure of year-round efficiency.

McNALLY PITTSBURG Systems automatically handle more coal per dollar—minimum maintenance costs.

The men who know coal from the ground up will be glad to study your coal-handling problems with you. Mail coupon.

McNALLY PITTSBURG

"The Men Who Know Coal From The Ground-Up"

McNally Pittsburg Mfg. Corp., Dept. PO, Pittsburg, Kansas
Gentlemen: Send more information on your Coal-Handling Systems.

Name_____ Title_____

Company_____

City and State_____

My biggest boner

Back in 1916 when I was in the Navy, I had to fill the various oil feeding manifolds. I drew the oil to fill them from a storage tank. But it ran so slowly it took a long time to fill the gallon measure. Being an eager beaver, I let the oil run while I oiled the pumps in the nearby fire room. On that job, the water tender asked me to help him lift a floorplate at the other end of the fire room. I gave him a hand and forgot the running oil.

Yup, it sure was a boner. All of a sudden I thought of the oil and made a dash for the tank. Boy! About five or six gallons of nice slippery engine oil was spread all over the floorplates. It took almost a bale of waste and a couple of hours to clean up those cleated floorplates. That put me in Dutch and I was reported for carelessness. It taught me this important lesson: Never leave an open valve.

C H WILLEY *Penacook, N. H.*

NUCLEAR PLANTS

Continued from page 106

administering an adequate industrial hygiene program. Since various methods may be used to adminster the program, we'll talk about the basic aims only:

1. Personnel monitoring: Perform daily and on a long term basis. Includes keeping detailed historical records.

2. Check degree of surface contamination in habitable areas of the plant.

3. Survey for allowable radiation exposure of power-plant components and assist in planning safe conditions for job setups in the plant. Provide consultation service in fixing allowable exposure times for personnel doing service and maintenance work.

4. Provide protective clothing and equipment. Includes laundry service. Check for safety in the plant service and maintenance programs.

5. Provide consultation on disposing radioactive wastes in all forms.

6. Check on compliance with federal, state and local requirements for handling shipments of radioactive or contaminated materials.

of contaminated components they will

7. Advise vendors on safe handling receive for repair or servicing.

8. Monitor areas surrounding plant, including soil and water. Control stack

(*Continued on page* 193)

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Call your nearby Tube Turns' Distributor. He can fill *all* your needs in welding fittings and flanges—aluminum as well as other piping materials. He provides industry's most complete line—over 4,000 top quality items—different sizes, types, schedules, materials; hence, this one source saves you purchasing time, cuts red tape. He acts as your warehouse. He gives you prompt delivery. And through him, Tube Turns' Engineering Service gives you valuable application help. To take advantage of this cost-cutting service, specify and buy TUBE-TURN Welding Fittings and Flanges.

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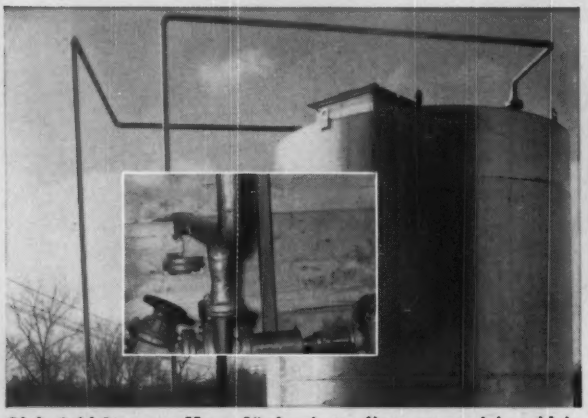
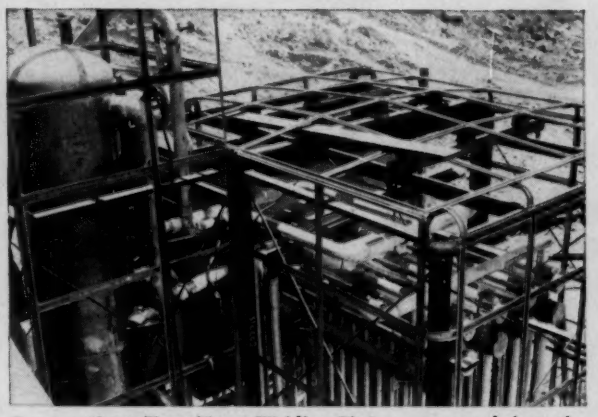
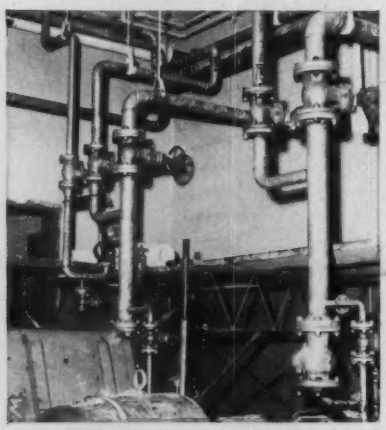
helps you apply aluminum piping on jobs like these...



Oleic Acid Storage: Here, 2" aluminum lines carry oleic acid in this installation for a rubber company. TUBE-TURN Aluminum Welding Fittings are used for directional changes. Insert shows a compact combination of these fittings at a pump . . . an elbow, tee, reducer and flange.

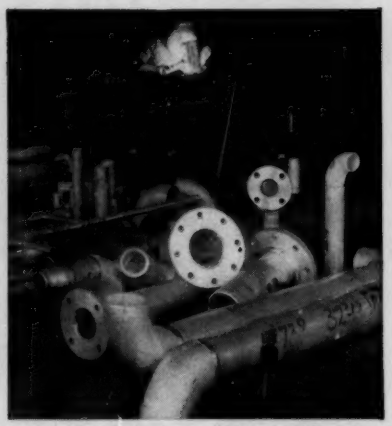


Oxygen Plant: TUBE-TURN Welding Fittings were used throughout this 25 tons-per-day oxygen plant for ore recovery. Here, operating temperatures range from 100°F to –320°F. Picture above shows reversing heat exchangers and fractionating tower prior to being enclosed in insulating shell.



Catalyst Piping: Aluminum piping and fittings were specified for certain services in this new TCR bead catalyst plant to prevent contamination of the catalyst. TUBE-TURN Welding Fittings and Flanges were employed in all aluminum lines from 1" to 10". Result: Lines are permanently leak-proof—maintenance is minimized.

Refinery Wax Coils: Originally, retubing of seven wax sweaters in a large refinery called for coils of another metal. Switch to aluminum piping and TUBE-TURN Welding Fittings saved $50,000 in material costs! Each unit required 900 TUBE-TURN 180° Welding Returns of 1" OD.



Fast Fabrication: TUBE-TURN Welding Fittings and Flanges are dimensionally accurate. Rigid inspection by Tube Turns assures true circularity and uniform wall thickness. Result: Alignment is perfect; fabrication is faster; installation simplified.

NEW BOOKLET—This new Tube Turns' catalog gives helpful information on aluminum pipe, fitting and flange materials. Mail the coupon for your free copy.

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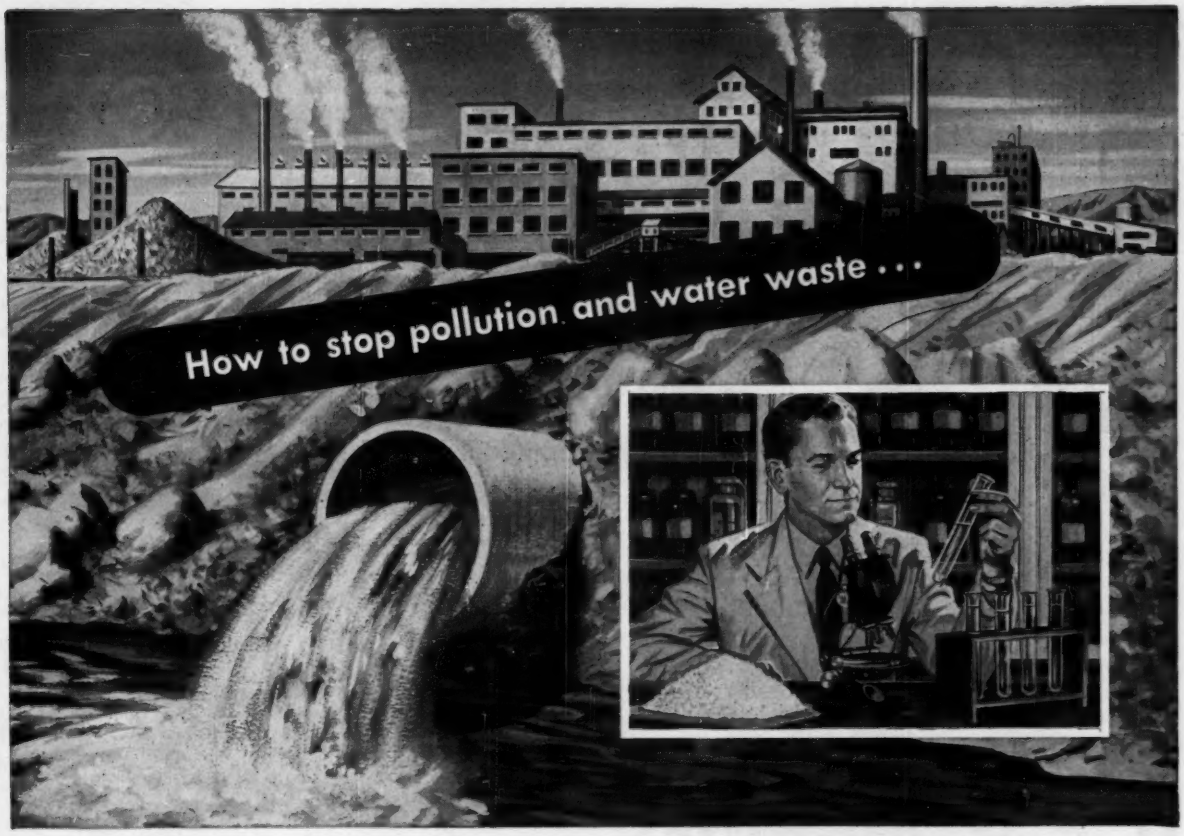
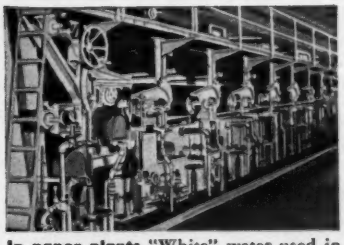


CELITE FILTRATION removes harmful impurities and purifies water for re-use



In paper plants "White" water used in paper formation is purified for re-use by Celite Filtration. The Celite method can also provide clean pure process water in many other industrial uses—for boiler make-up, heat exchangers, circulating water for towers, etc.

In oil wells—output is boosted by re-pressurizing wells with water to force out accumulated oil. Celite Filtration purifies water to the extreme degree required—removes the minute suspended impurities which would otherwise clog the microscopic pores of sandstone.

CELITE* FILTRATION can reduce your process water costs materially—and it can greatly aid your community's water conservation and anti-pollution programs.

If your plant now discharges industrial water as waste, Celite Filtration enables you to purify this water for *re-use*—at relatively low cost. Celite removes all types of suspended solids. When required, it even filters out fine matter such as amoebae and algae, many of which cannot be removed by other methods. Thus by recycling process water you can save on water costs . . . and save your community's water.

At such times as you still find it necessary to discharge process water, Celite Filtration is an important anti-polution measure. It helps make water safe and harmless . . . thereby protecting your community's recreational areas, fish and wildlife.

Food processors, beverage manufacturers, swimming pool operators and many industrial users of process water depend on Celite Filtration.

It will pay you to investigate the unique advantages of Celite for your particular application. Celite itself is carefully processed from the purest deposits of diatomaceous earth. It comes in nine standard grades, and you are always assured of utmost uniformity of product. To have a Celite engineer study your problem and offer recommendations, simply write Johns-Manville, Box 60, New York 16, New York. In Canada, 199 Bay Street, Toronto 1, Ontario. *T.M. Reg. U.S. Pat. Off.

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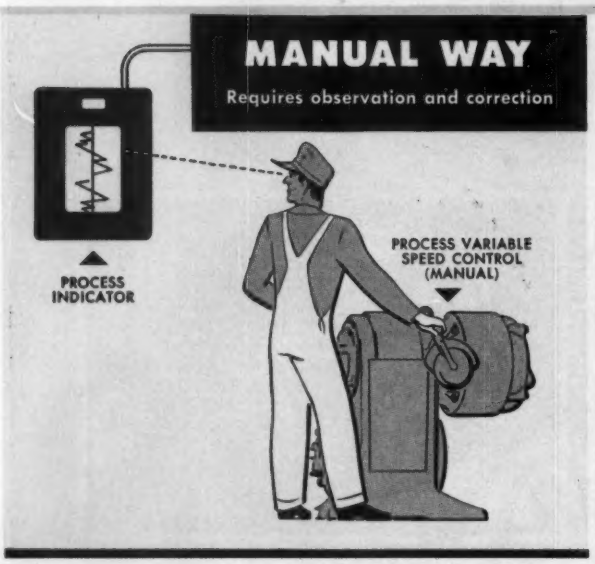
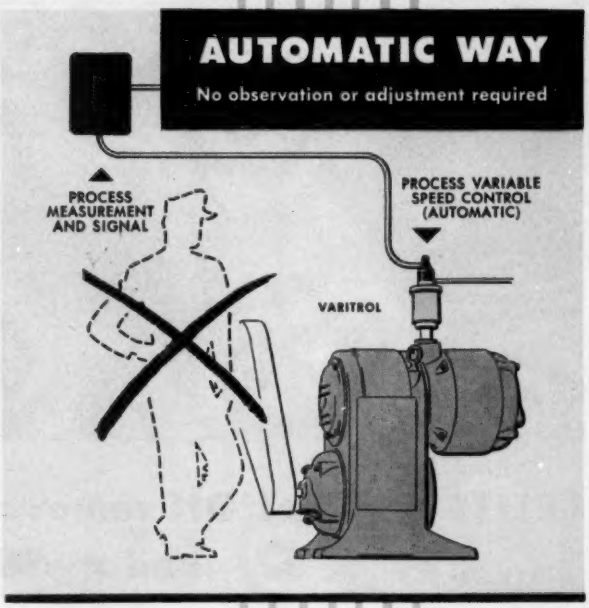
Johns-Manville CELITE FILTER AIDS

HOW VARITROL AUTOMATIC SPEED CONTROL saves Manpower





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NUCLEAR PLANTS

Continued from page 188

effluents and prevent outside air contamination.

Carrying out these responsibilities successfully is essential for welfare of plant personnel and plant neighbors.

Publications that help in setting up an adequate program include the National Bureau of Standards Handbooks: *No. 42—Safe handling of radioactive isotopes; No. 51—Radiological monitoring methods and instruments; No. 52—Maximum permissible amounts of radio-isotopes in the human body and maximum permissible concentration in air and water; No. 59—Permissible dose from external sources of ionizing radiation.*

The U.S. AEC publication, *Handbook of federal regulations applying to transportation of radioactive materials*, contains references that will help in providing handling equipment for radiactive materials. All these publications can be bought from the Superintendent of Documents, Washington 25, D.C.

Second installment of this article will appear in a forthcoming issue.

WATER GAGES

Continued from page 116

Disassembly. Shut gage and gage-line valves, Fig. 1, and open drain. When loosening cap screws, work toward the center of the cover. Use guide pins to support the cover, Fig. 2. Note that molybdenum-disulfide (*Molykote*) is used in the gasket groove. Do *not* use graphite.

New parts. Always install a new set of gaskets and micas. All contacting surfaces of these parts should be clean. Avoid handling them roughly; they seal high pressures.

Best practice is to use a new glass. If an old one is reused, check to be sure it is not chipped or scratched. Replace the glass in the position it was in when removed from the gage. Mark the glass so it can be replaced correctly. Renew the end tapes on the glass, registering them carefully. Do not allow the tape to lap over either face of the glass.

Reassembly. Check to make certain that the stop collars of the cap screws, Fig. 10, are tight against the shoulder. Assemble the cap screws in the body, making each finger-tight before using the wrench.

Tighten the two center cap screws about one-quarter of a turn to support the full weight of the cover, Fig. 9, before removing the guide pins. With the body still hot from using the gage

RELIABILITY... in the DARLING gate valve picture!

Example: Where severe line condition forces valve seats out of alignment, Darling's unique wedging principle allows discs to adjust tightly against both seats.

THERE'S a sure way of minimizing valve leakage, down-time and a lot of costly maintenance for years on end. Try Darlings!

Darling's *fully revolving double disc parallel seat* principle does the trick . . . by distributing disc and seat wear uniformly, by compensating for valve body distortion, assuring tight closure under the most adverse conditions.

Darling gate valves are made in metals, types and sizes for most services . . . and for pressures up to 1500 pounds. Name your service and write for Bulletin No. 5003.

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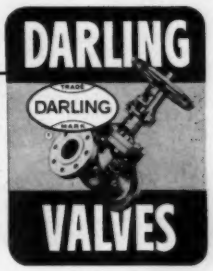
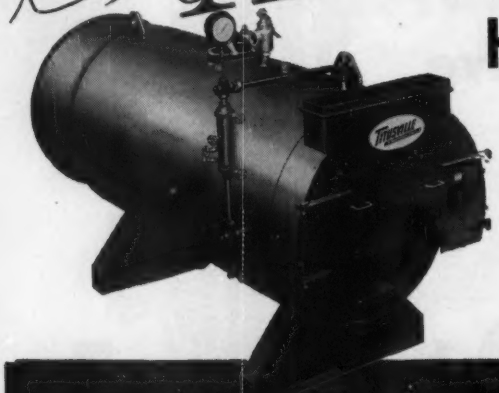
Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.



"Customer Acceptance"



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WATER GAGES

Continued from page 193

before closing the valves, partly tighten all cap screws, taking down gradually and uniformly. Start at the gage center and move crisscross toward the end of the cover.

Continue tightening all cap screws until the shoulder seats firmly on the body, Fig. 10. But do not force them beyond this position. There is no need for preheating before shouldering the cap screws.

Heat up gage to restore it to service by opening drain valve wide. Crack upper gage valve (steam connection from boiler) and then open the lower gage valve. Allow gage to heat without pressure buildup for five minutes. Then close the drain valve slowly and allow pressure to build up for 15 to 20 minutes. Close drain valve tight, open all boiler-to-gage valves wide. Gage is now in service.

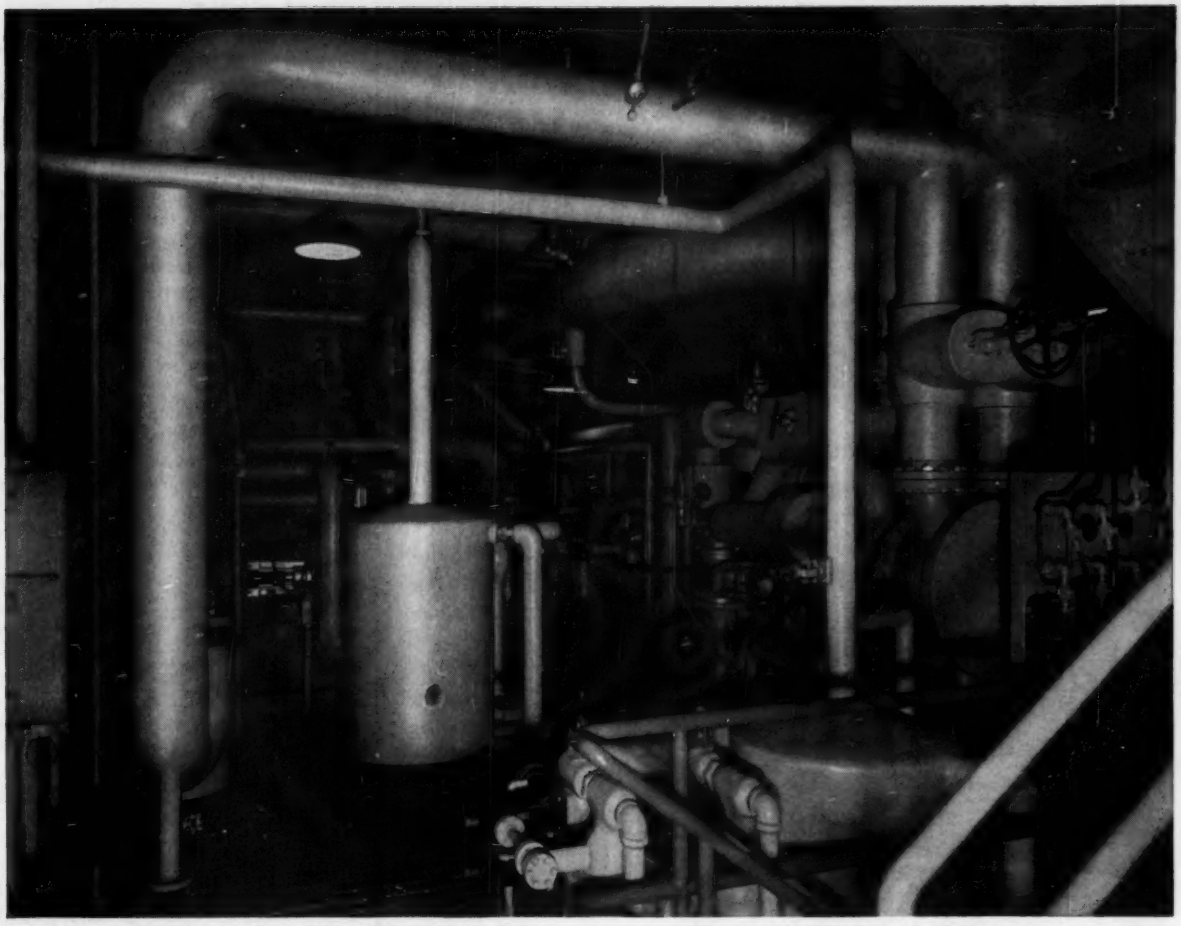
HYDRO TEST

Continued from page 103

system. This is done by connecting the wheel case to a steel cylinder, which is in the head tank but separated from it by rubber seals. This mounting prevents any movement of the pressurized tanks from affecting alignment of the runner and shaft, thus causing extra friction and other difficulties. To remove the wheel case the barrel assembly is lifted by crane through the top of the head tank and lowered to the laboratory floor where it can be easily taken apart and reassembled. With the barrel assembly in place in the tank the runner can be detached from the shaft and taken from the stand after lowering a short elbow section of the draft tube.

To obtain the hydraulic thrust for each test point all rotating parts, including turbine runner, shaft and dynamometer rotor, are supported on a Kingsbury thrust bearing in the top of the dynamometer stator. This, in turn, is suspended from an Emery load cell by a torsion-free rod. The latter permits all torque developed by the turbine to be measured by another Emery load cell equipped with a highly accurate 3-range indicator.

To pressurize the system two pumps, each driven by a 300-hp motor, are rated 9500 gpm under 118-ft head, arranged to operate in parallel or in series. In series, they develop 300-ft head and supply 5000 gpm. In parallel, they discharge 21,000 gpm against 100-ft head. A 100-ton cooling system holds the 10,000-gal stand capacity at a constant temperature. Water to be



Condensate piping and heater drains in this power plant are insulated with 1½" K&M "Featherweight" 85% Magnesia. K&M insulations are also used on other equipment in the plant.

reduce HEAT LOSSES . . . *cut* OPERATING COSTS with K&M "Featherweight" 85% Magnesia Insulation

Every BTU lost through inefficient insulation directly increases operating costs . . . every BTU kept for work in the system is money saved. It's this dollars and cents view that indicates the need for K&M "Featherweight" 85% Magnesia . . . the EFFICIENT insulation that time does not harm.

K&M "Featherweight" is made of 85% basic carbonate of magnesia and asbestos fiber. It efficiently insulates piping and equipment to 600°F. and is good for the life of the equipment it serves.

For temperatures up to 1900°F. there is K&M Hy-Temp Combination. It's made of a layer of K&M Hy-Temp (diatomaceous silica) covered with "Featherweight" 85% Magnesia. These two layers are laid with staggered joints—thus, heat losses that normally occur through expansion-opened joints are eliminated.

For more information on these heat- and money-saving K&M High-Pressure Insulations, contact your K&M distributor, who is an experienced applicator. Or, write directly to us.

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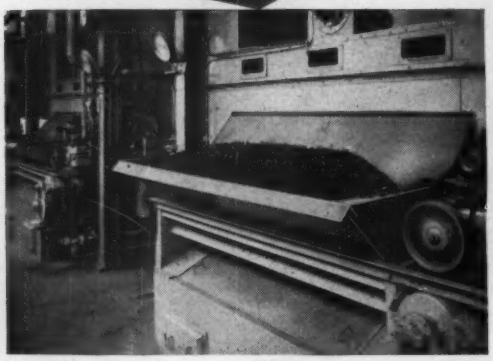

In 1936, Krey Packing Co., St. Louis, Mo. installed two Laclede Forced Draft Chain Grate Stokers to fire two 35,000 PPH steam generators. Here is the outstanding 20 year record of these two stokers which are still operating most satisfactorily.

OPERATING CONDITIONS

335 lbs. pressure saturated steam
218°F feedwater temperature
No heat recovery equipment
Rear wall water cooling only
Heating value of coal — 11,000 BTU per lb.

KREY'S DATA FOR 20 YEAR PERIOD

Average load per steam generator	32,000 PPH
Average 4 hour peak load per steam generator	45,000 PPH
Number of hours in operation per stoker	149,760 hours
Number of hours in 20 year period	175,320 hours
Percentage of time each stoker has been in operation	85.4%
Coal burned per stoker	320,000 tons
Average evaporation per steam generator	7.5 lbs. of steam per lb. of coal
Average overall efficiency of each steam generator	70.2%
Total cost of repair parts for both stokers	$650.91
Total cost of repair parts per ton of coal burned	1/10 cent

During the establishment of this outstanding record, Krey Packing Co. purchased a third Laclede Forced Draft Chain Grate Stoker in 1945.

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HYDRO TEST

Continued from page 194

cooled is taken from the high-pressure side of the pumps and returned to the suction.

After a model runner is assembled in the head tank and its access door closed and sealed, the system is filled with water. This operation takes about 15 min. Pumps are then started and the system pressurized. All mercury and water manometers are bled and zeroed. Test runs are made at 5-min intervals, allowing 1 min to set up the new test conditions, 3 min for transients to smooth out and 1 min for the actual test. Test runs can be made at 3-min intervals by decreasing the time allowed for transients to settle, but the 5-min cycle permits each test point to be calculated and plotted as the test progresses.

A complete test on a francis turbine including power and efficiency, and runaway speed versus sigma, can be run in four days. Five men conduct a cavitation test, located at the dynamometer control panel, venturi manometer, headwater manometer, tailwater manometer and the computer's desk. Four of the five men double as assemblers for setting up and dismantling the equipment to be tested. This permits them to acquire a more detailed knowledge of the turbine tested.

This new high-head test stand is used for basic research and to make formal contract acceptance tests with particular emphasis on duplicating field conditions. Some of the outstanding projects using the stand are:

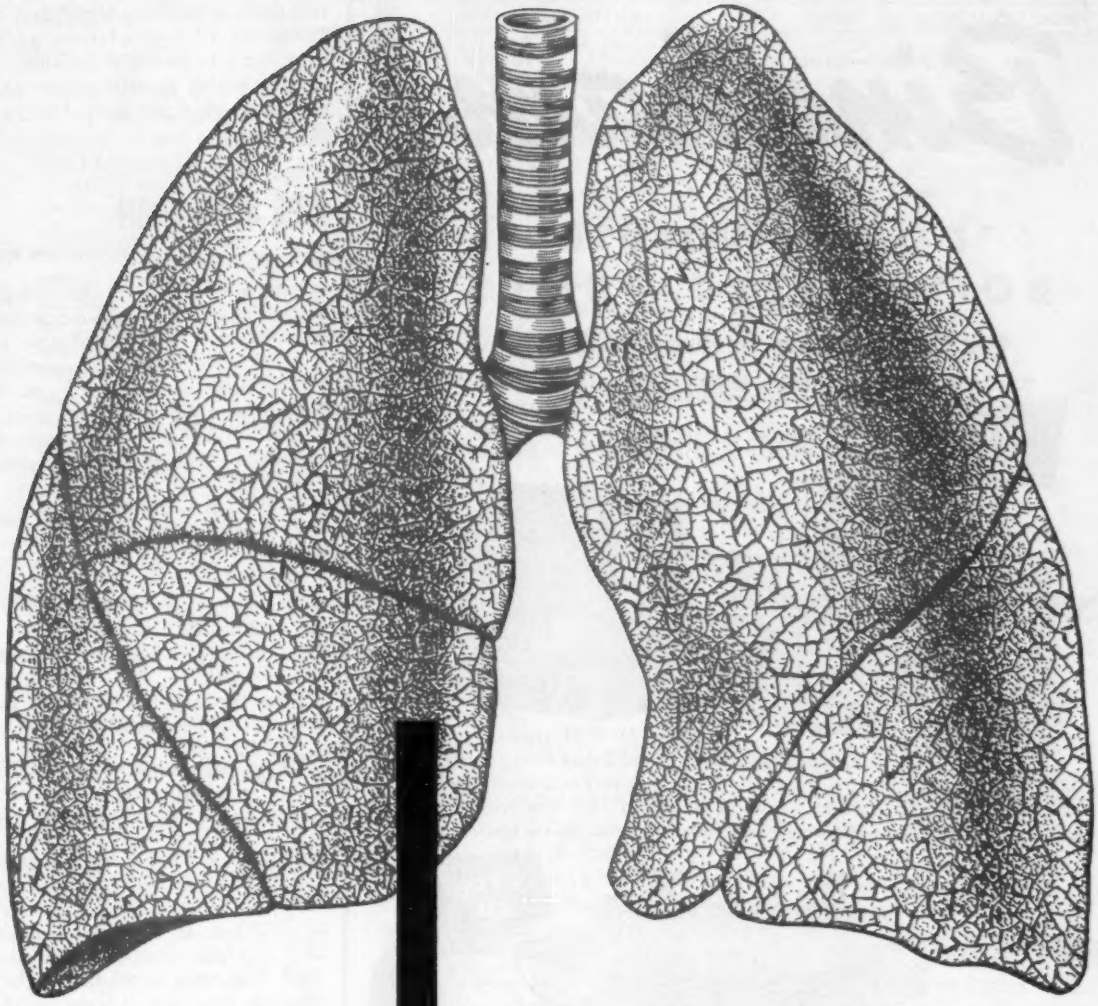
1. Complete development of the francis runners, wicket gates and stay vanes for Brownlee project of the Idaho Power Company in Hell Canyon on the Snake River, where four 144,000-hp 128.6-rpm 250-ft-head units are to be installed.

2. Model studies will be made for the Ice Harbor project of the U.S. Engineer Corps on the Snake River, for which four 143,000-hp 90-rpm 89-ft-head kaplan turbines, the highest-powered units in the world, are on order.

3. City of Seattle, Wash. is increasing the head on its Gorge plant from 275 to 325 ft. As a result of extensive tests in this high-head laboratory it will be possible to increase the rating of the turbines from 27,500 to 45,000 hp at good efficiency.

4. Continuous basic research is being conducted in this stand on kaplan and propeller turbines with particular reference to high-head applications. Also, research is planned to investigate cavitation characteristics of high-head francis turbines.

5. For the first time in this country,



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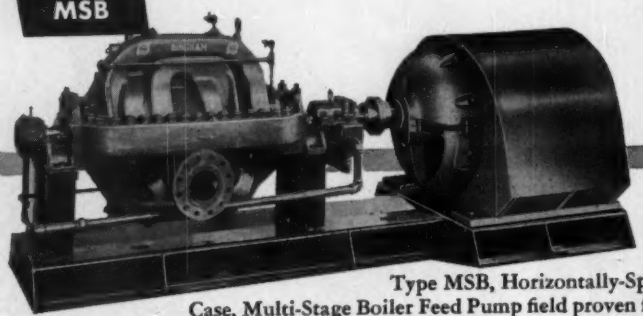
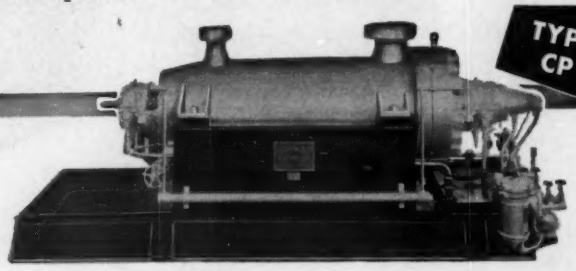
TYPE MSB



Type MSB, Horizontally-Split Case, Multi-Stage Boiler Feed Pump field proven for 1200 lbs. working pressure. Integrally cast cross-overs and evenly spaced case bolting located uniformly close to the shaft center line, enclosing a minimum pressure area, eliminate case distortion and inter-stage jetting.

TYPE CP



Type CP, Multi-Stage, Double-Case Boiler Feed Pump with forged outer barrel for high pressure service.

All BINGHAM Boiler Feed Pumps feature: (1) "Double Volute" construction, resulting in full radial balance of the rotating element *throughout the entire operating range of the pump.* (2) Double suction first stage for low NPSH. (3) Balanced axial thrust (no balancing drums needed). (4) Kingsbury Thrust Bearings. (5) Stuffingboxes subjected to suction pressure only. (6) Design for High Speeds.

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HYDRO TEST

Continued from page 196

hydraulic laboratory equipment is available that can duplicate actual field conditions for all kaplan-turbine applications likely to be found anywhere. Its use for testing francis-turbine models also opens up a new field of cavitation research.

PIPE INSULATION

Continued from page 93

to pipe surface); r = distance from center line of pipe to ground reference point, feet; R = radius of pipe, feet; t = time since start of operations, hours (4-month summer); T_1 = temperature of ground reference point (70 F assumed); To = temperature pipe surface, F (chilled-water temperature assumed); W = rate of heat flow per unit area, Btu per hour per square foot; Q = total heat transfer, Btu per hour.

Calculations. For a 12-in. 39.5-F chilled-water line, $a = k/pc$, $a = 1.2/(98)\ (0.45) = 0.0272$ sq ft per hr. $Z = at/R^2$, $Z = 0.0272\ (2880)/(0.5)^2 = 313$.

From the table for $Z = 313$ and $P = 1$, $G\ (Z,P) = 0.496$. Then, $T_1 - To = \frac{2\pi RW}{k} G\ (Z,P)$, or $70 - 39.5 = \frac{2\pi\ (0.5)\ (W)}{1.2}\ (0.496)$. Solving for W, $W = 23.5$ Btu per hr sq ft.

Since there is 3400 ft of 12-in. pipe, its total area = $3400 \times 3.34 = 11{,}340$ sq ft. Then, $Q = W$ (total area) = $23.5 \times 11{,}340 = 266{,}000$ Btu per hr. With 1345 gpm of chilled water circulating, temp rise of water = $Q/500$ (gpm) = $266{,}000/1345\ (500) = 0.396$ F. An allowance of 0.5 F was made, which was on the safe side for the 39.5-F water.

Similar calculations for an 18-in. 45-F chilled-water line give the water-temperature rise as 0.153 F for the supply system and 0.104 F for the 53-F return line.

After calculations were completed, an allowance of 0.5 F was made for each 3400 feet of pipeline. Sufficient refrigeration capacity was available for the intended installation to handle this additional heat gain. Because it was unnecessary to provide additional refrigeration equipment to make up for the heat gain, it proved uneconomical to insulate the piping. The insulation cost was considerably higher than the additional operating costs because of the heat gain.

Final test results. Temperature tests were conducted on the installed pipe-

DIESEL ENGINE TROUBLE CHART

POOR COMBUSTION:

Possible Cause

- Wrong fuel
- Wrong injection timing
- Sediment or slugs of water in fuel
- Leaky injection valve
- Carbon on injector
- Overheated injector
- Improper size orifice
- Subnormal compression temperature
- Injector valve sticking
- Weak injector valve spring
- Air in fuel lines
- Incorrect valve timing
- Leaky valve or valves
- Stuck piston rings
- Subnormal water jacket temperatures
- Worn cylinders
- Intake or exhaust ports clogged (2 cycle engines)
- Light loads
- Cold intake air
- Overlubricated cylinder walls

EXHAUST SMOKE:

Possible Cause

- Weak compression
- Sticking or worn nozzle
- Cetane fuel too low
- Excessive amount of oil reaching combustion chamber
- Unequal power output of cylinder
- Dirty air filter or silencer
- Misfiring
- Leaky inlet or exhaust
- Inadequate air supply
- Sticky or worn piston rings
- Inlet air or jacket water too cool
- Worn or scored cylinders

HIGH OIL TEMPERATURE:

Possible Cause

- Overheated bearing surfaces
- Not enough oil in circulation
- High water jacket temperatures
- Crankcase insufficiently cooled
- Plugged oil cooler
- Oil badly contaminated
- Late combustion
- Overloading

ENGINE OVERHEATS:

Possible Cause

- Lack of cooling water
- Incrustations in water jacket
- Obstruction to circulation of the water
- Damage to water pump
- Fuel injection too late
- Inadequate lubrication

CYLINDER WEAR:

Possible Cause

- Corrosion caused by water from products of combustion or by leaky head gasket
- Abrasive material from dust in air
- Sulphur loaded fuel
- Insufficient or incorrect oil
- Overheating
- Blow-by
- Frequent cold starts
- Piston ring pressure too high
- Misaligned connecting rod
- Cylinder distortion

HIGH OIL CONSUMPTION:

Possible Cause

- Loose bearing fits (in pressure system)
- Excess oil reaching cylinders
- Bearing end play excessive
- Plugged oil wiper rings
- Oil pressure too high
- Oil diluted with fuel
- Oil leaks
- Piston rings not fitting properly
- High oil temperature

CITIES SERVICE C-300 DIESEL OIL: ANSWER TO MANY PROBLEMS!

As is evident by the chart, many problems experienced with diesel engines can result from insufficient lubrication or the use of an unsuitable oil.

To avoid these problems before they begin, an increasing number of diesel operations have switched to Cities Service C-300 Diesel Oil. The reason: Cities Service C-300 is made from the finest base oils to conform to Military Specification MIL-0-2104A . . . is high detergent and high dispersant . . . strongly fortified against oxidation and corrosion.

But results are what count and here are the outstanding results reported by users of Cities Service Diesel Oil. Says a leading power plant: "We get 23,205 brake horsepower hours per gallon of lube oil." Says another: "Engine compressions are the same after four years as after three months; liners worn only .0015"." And still another reports over 30,000 hours of use on its Nordbergs—six years without any appreciable wear using Cities Service Diesel Oil!

In short, users are unanimous in praising Cities Service Diesel Oil as the finest they've ever used. Try it and you'll agree. Talk with your nearby Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

COMBUSTION CHAMBER DEPOSITS:

Possible Cause

- Dust from air
- Imperfect combustion
- Unsuitable oil

ENGINE ROUGHNESS:

Possible Cause

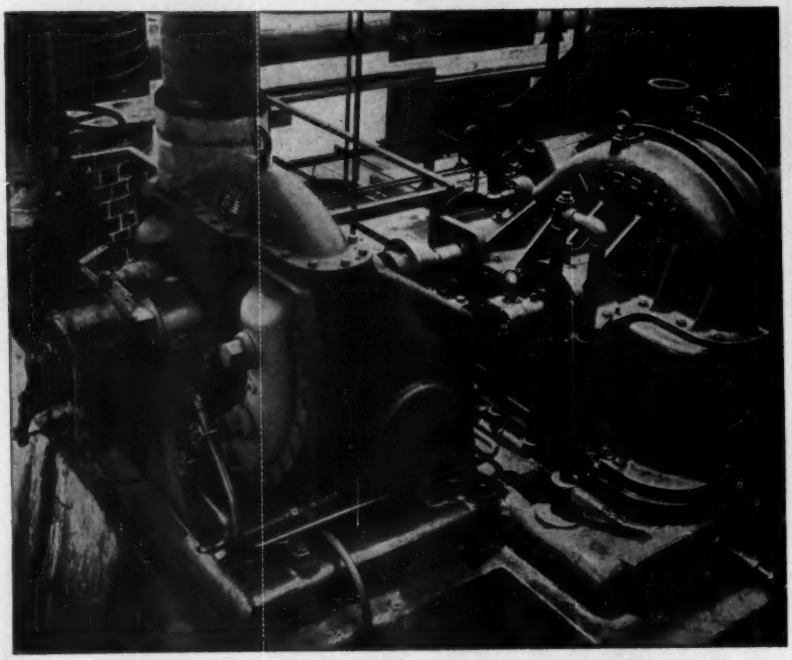
- Imperfect injection
- Cetane number of fuel too low
- Injection timed too early

SUDDEN STOPPAGE:

Possible Cause

- No fuel
- Water or air in fuel line
- Too heavy fuel
- Dirt or gum in fuel
- Plugged fuel line
- Lubrication failure
- Overheated engine
- Seized or tightened moving part of engine

Murray Turbines



One of 4 Murray type U turbo-gear units installed in a southwest rubber plant still giving trouble free service after 12 years in an unprotected outdoor location. This unit drives an Induced Draft Fan requiring 425 HP at 683 RPM. The turbine speed is 3500 RPM.

● Murray turbo-gear units for mechanical drive are right at home in difficult outdoor installations. Fans, pumps, compressors, and many special types of slow speed machines are among the long list of installations powered by Murray turbo-gear units.
Murray gears are of the Herringbone or Double Helical type and all are pressure lubricated at the point of tooth contact.

MURRAY IRON WORKS COMPANY
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Builders of Steam Power Equipment for Three Quarters of a Century

PIPE INSULATION

Continued from page 198

lines after a short period of operation. Indications were that the calculated values were somewhat on the low side. However, the 0.5-F allowance was sufficient to compensate for the actual gain. The fact that the calculations proved on the low side was difficult to understand because the values used were for the worst case.

Possibly the formula used has a greater error for larger pipelines than was anticipated, or conditions had not become reasonably stable since the plant did not operate continuously during the 4-month period. The author is interested in learning if a better solution to this type of problem is available.

TURBINE PUMPS

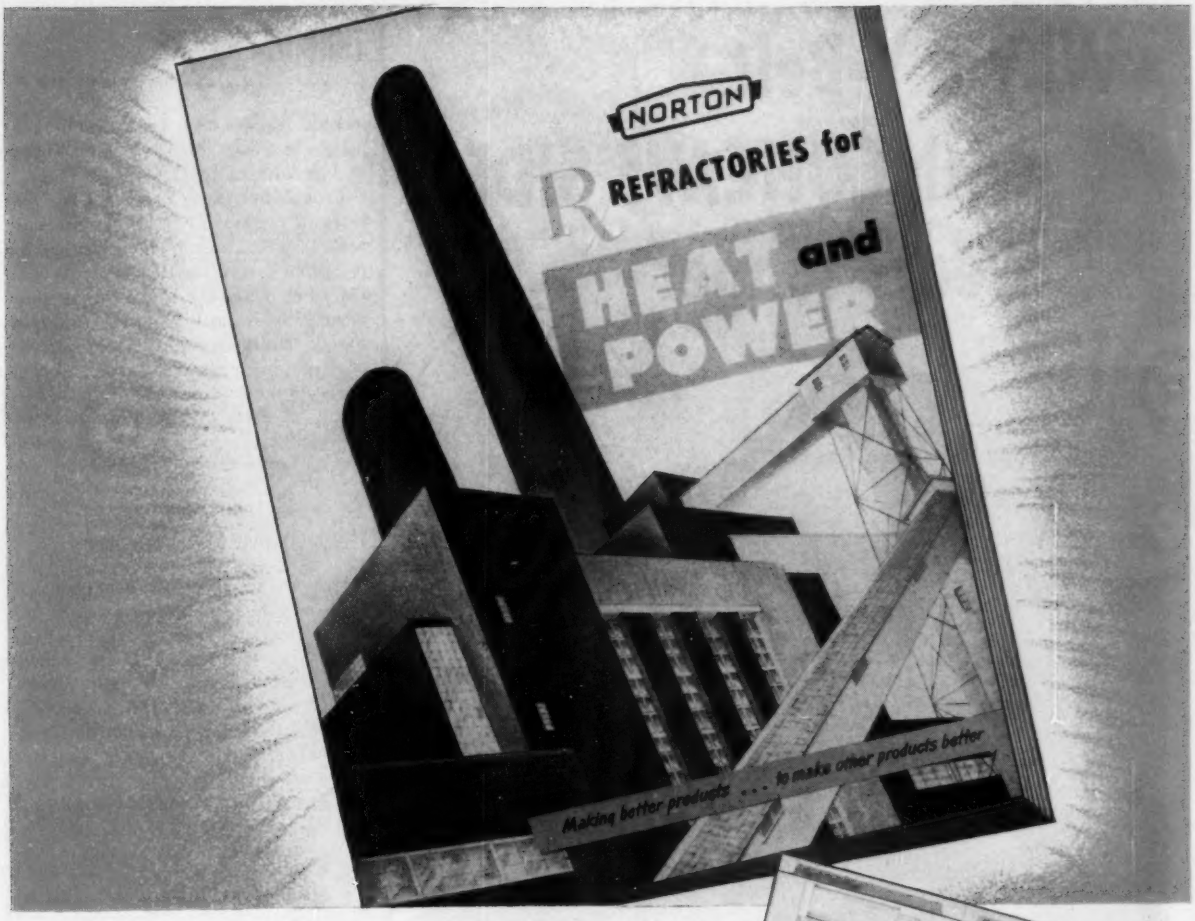
Continued from page 90

phenol-plastic bearings. This separation from sand and water, together with the protective oil film, adds to the life of the shaft and bearings.

The open line shaft is usually supported in rubber bearings, at which point the shaft may have a journal sleeve of special alloys. This is intended for water lubrication and can handle suspended sand due to the fluted bearing construction and materials. Note that running clearances are much greater than with bronze bearings so the magnitude of vibration is much higher. There is some question that the natural damping quality of rubber effectively suppresses the vibration due to general misalignment or to critical speed. Exposure to corrosion of the shaft, which is usually low carbon steel, results in tuberculation and increasing shaft horsepower loss reflected in a higher power cost. Correct size of the column pipe should be determined by comparisons on the basis of initial cost and power cost due to the change in friction losses, Fig. 3.

Pump drive. The motive power, another important element of the system, deserves careful thought. The horizontal or vertical steam turbine can be used where the range of head capacity dictates extremes of speed. Because turbine and pump have similar torque characteristics they are effectively coupled. A typical plot of horsepower versus rpm of a steam turbine is shown in Fig. 6a.

For a smaller speed range the gas or diesel engine has useful flexibility. Both vertical and horizontal types are available. This type of drive requires a suitable clutch that can be supple-



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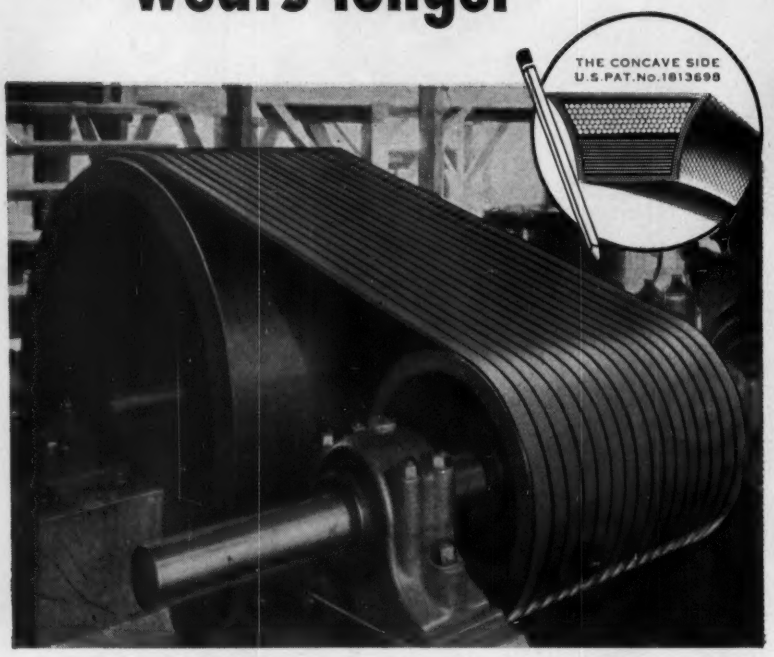
Why a V-Belt with CONCAVE SIDES wears longer



It is easy to demonstrate to yourself why the concave sides (Fig. 1) of the Gates belt greatly lengthen belt life.

Simply bend a Gates belt and feel the sides. Notice how these precisely engineered concave sides *fill out* on the bend and *become straight*. Thus a Gates belt grips the sheave groove evenly (Fig. 1-A) and wear is distributed uniformly across each side of the belt. That means longer belt life; lower costs.

Make the same test with a straight-sided belt (Fig. 2) and see what happens. The sides bulge out on the bend (Fig. 2-A) concentrating the wear at points shown by arrows.

To assure longer wear and keep belt costs down, specify the V-belt with Concave sides—Gates Vulco Rope . . . readily available from nearby distributor stocks. The Gates Rubber Company, Denver, Colorado—*World's Largest Maker of V-Belts.*

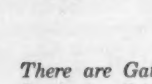


Fig 2

There are Gates Engineering Offices and Distributor Stocks in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

TFA 90

Gates VULCO ROPE Drives

TURBINE PUMPS

Continued from page 200

mented to advantage by hydraulic couplings or gears. See Fig. 6b for general performance characteristics.

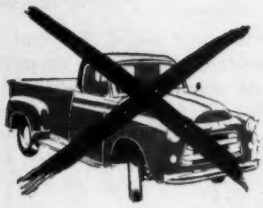
Probably the most common drive that is readily adaptable to full automatic control is the electric motor—either the induction or synchronous type. As with the other drives the pump torque characteristics are easily adapted. Note from Fig. 6c that the motor efficiency in terms of output horsepower is broad and combines to advantage with the turbine pump for extreme changes of head capacity even though the choice of speeds may be more restricted. Efficiency and power factor can be improved by using the synchronous motor, but there is a low limit of horsepower below which it is not economical.

Delivery piping, with the various fittings and flow devices, completes the load system and warrants thorough investigation. Dimensional data, such as elevations, lengths and tentative diameters, should be represented in suitable graphic form so they can be considered with other factors like shock and friction losses and the effects of age or deposits on the total investment and operating expense. Thus, an oversize pipe system may represent a saving when properly amortized.

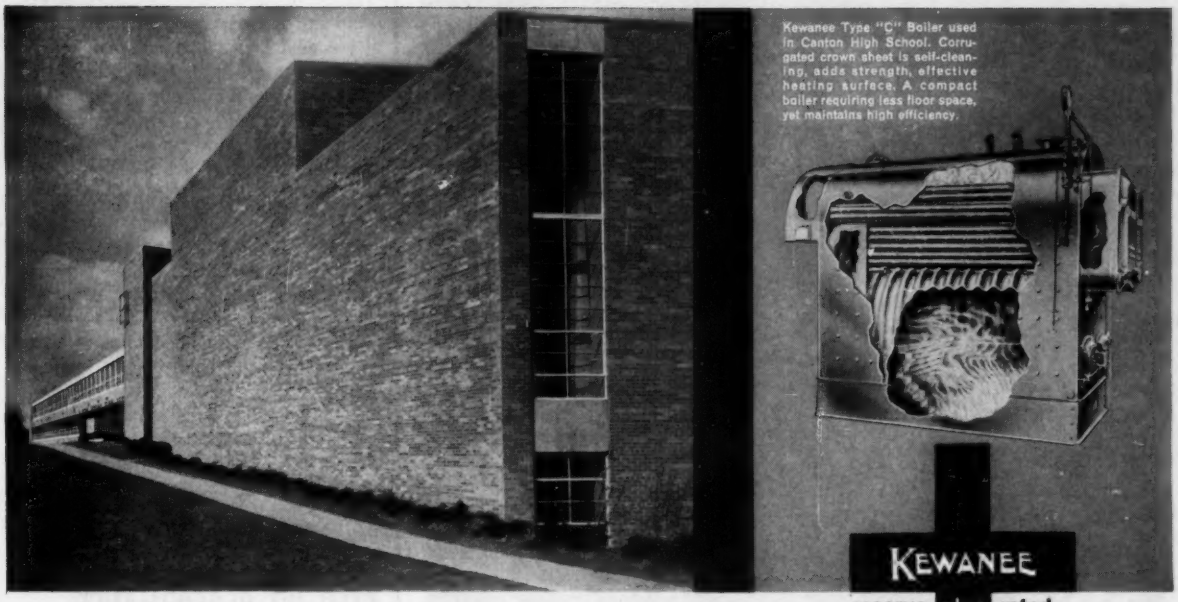
For most demands, the objective desired is a net quantity of water (gallons or cubic feet). Any added power to develop pressure or velocity is intangible. For example, a plant that delivers large quantities at low levels, while maintaining simultaneously a small quantity at an extremely high elevation or pressure, reflects serious power waste due to the large quantity and high pressure. An auxiliary plant for this small quantity would be preferred.

Controls. Effective and safe operation of the total plant depends on suitable controls. The well and pump should be protected and guided by floats or other level detectors. Lubrication controls should be provided for the shaft bearings. For the open line-shaft type of column, the device should prelubricate and postlubricate during starting, stopping and reversing phases. The antireverse ratchet can be used to some advantage if no reversal is permitted.

Speed controls, which are necessary for drives other than electric motors of the induction type, should be coupled with suitable pressure devices for stabilizing the system. Overload protection is provided for the electric drive for such typical conditions as sand-locking or interference from sticks, stones or other obstructions at the impeller. Whether any of these devices should be fully automatic or manual depends on



No service calls in 2 years with "*Cruising Speed*" operation


Kewanee Type "C" Boiler used in Canton High School. Corrugated crown sheet is self-cleaning, adds strength, effective heating surface. A compact boiler requiring less floor space, yet maintains high efficiency.
KEWANEE
reserve plus rated

Canton High School, Canton, Illinois
Architect—Atkins, Barrow & Lasswith (now Atkins, Barrow & Associates) Urbana, Illinois
Engineer—Consulting Engineering Service, Urbana, Illinois
Heating Contractor—Hays Plumbing & Heating Company, Urbana, Ill.

■ Canton High School votes experience the best teacher in selecting boilers...

There's an old saying that goes like this... "Experience is the best teacher." The Canton High School, Canton, Illinois, prides itself on its fine academic teaching staff. But for knowledge of boiler operation, old "Dr. Experience" gets the call. So, when it came to selecting a boiler, school executives, the architect, engineer and contractor took a page from the past and chose Kewanee Reserve Plus Rated Boilers. Yes, experience proved Kewanee "cruising speed" boiler operation gave trouble-free performance with lower fuel and maintenance costs—higher efficiency, too. In 2 years there has not been one single service call. But that's easy to understand because "cruising speed" boiler operation guards against breakdown—there's less strain, less wear, higher efficiency, lower maintenance and fuel costs. And Kewanee reserve takes care of fluctuating demands and high power peaks, because Kewanee Boilers are rated on nominal capacity which guarantees 50% extra built-in power. Boilers rated on maximum capacity have no reserve to meet emergencies—must operate constantly at top speed—require more maintenance. So take a tip from those who have learned from experience and choose Kewanee Boilers. You'll be money ahead if you do. KEWANEE BOILER DIVISION OF AMERICAN-STANDARD, 101 Franklin St., Kewanee, Illinois.

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American
ROLLING RING
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COAL IS SPLIT
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Proved by Hundreds of Millions of Tons of Reduced Coal.
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COAL PREPARATION PROBLEM?
Write for Recommendations and Literature.
American
PULVERIZER COMPANY
1349 MACKLIND AVE. • ST. LOUIS 10, MO.

TURBINE PUMPS

Continued from page 202

size, location or use of the plant.

Valuable supplements to the pumping plant are recording devices for the flow quantity and rate, discharge pressure and water level and power measurements. These aid the supervisor in decisions affecting the total plant.

Total plant becomes a serviceable unit when the components are combined to operate within the prescribed limits. The factors of quantity, pressure, power, time and materials are summarized for the economical range and safe operation shown in Fig. 3. Use of the system beyond these limits clearly shows the waste of the power dollar (kwhr per 1000 gpm) and the possible abuse of the well, pump or drive.

Because constructive supervision requires judgment and experience, such an investment is greatly augmented by carefully kept records of the pumping quantities, time, cost and the manhours required for repair or replacement. This information should be supplemented by a library with books, notes, papers, sketches and drawings pertaining to the components. From this background a thoughtful decision can be made—for example, to add more units instead of overloading the existing ones, or to decide when to repair the old equipment or to replace it with modern units.

STEP UP PERFORMANCE

Continued from page 113

2. Disciplinary problems. "One of my employes was doing poor work. After several fruitless discussions on every unsatisfactory incident that had occurred, he received warning. Finally I discharged him. Performance Record helped me keep facts and dates to support this action."

3. Promotion problems. "I had a job that needed extra effort and a sense of responsibility. In considering three men, I looked over their Performance Records. This information helped me make a decision."

4. Training problems. "My department called for selecting and training an employe to install and repair special equipment. The man selected had the right background. This was backed by effective incidents under relevant headings on his Performance Record. This warranted giving him additional training. He is rapidly becoming valuable to the department because he learns quickly how to maintain his equipment."

Other program uses. Most immediate and easily observable results due to using Performance Record at this

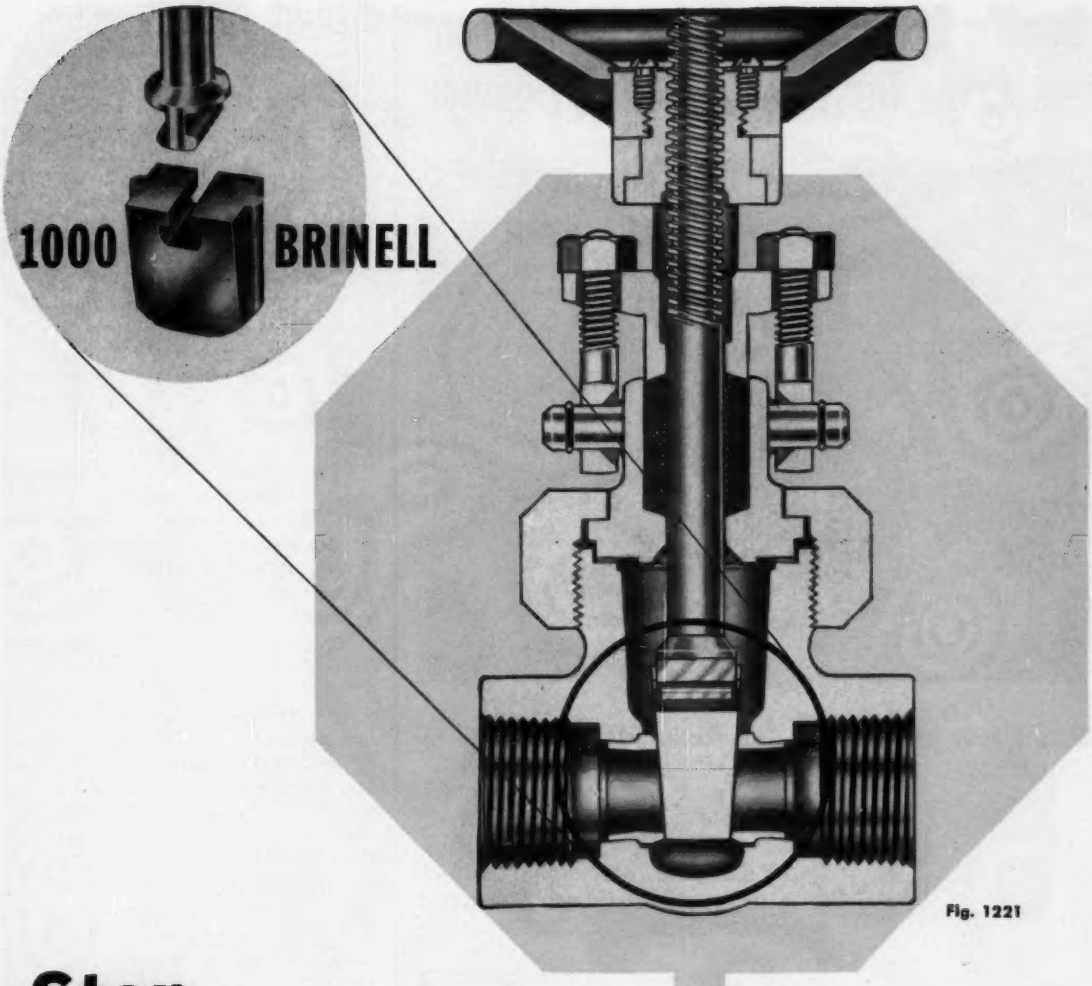

Fig. 1221

Stop Galling with the hardest valve wedges you can buy

Highly resistant to erosion and corrosion

Here's a wedge as hard as flint . . . so hard that it's undamaged by pipe cuttings, scale or grit. It's the only trim we know of which will successfully withstand the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling. This wedge is *13% chrome stainless steel hardened up to 1000 Brinell.*

Specify the OIC 1221 gate or 1621 globe where you need the extra rugged nature of forged steel. They are recommended for steam service up to 800°F...oil service up to 1000°F. Or, use these same valves for hydraulic service up to 2000 lbs.

Write for Form 195 for specifications on the OIC forged steel line.

OIC VALVES | FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

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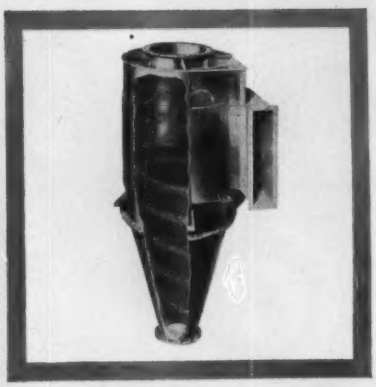
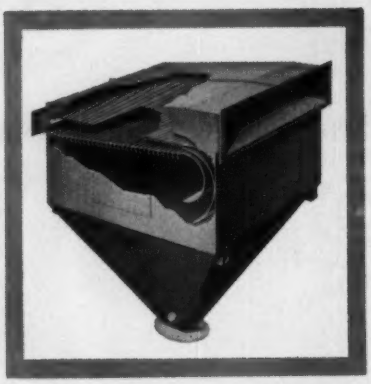
How Buell's Exclusive Rapping Mechanism delivers Extra Dust Collection Efficiency



Buell Cyclones offer two "extra-efficiency" advantages: (1) exclusive Shave-off which harnesses double-eddy and puts it to work, and (2), large diameter design which eliminates clogging.

Complementing the extra efficiency of rapping in Buell "SF" Electric Precipitators, the unique Spiralectrodes add further efficiency through 50% to 100% higher electron emission, constantly accurate spacing, longer electrode life.



Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations. Ideal for boilers from 100 to 2000 BHP.

For more specific data about Buell's *extra efficiency*, write Dept. 50-H, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

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MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in
DUST COLLECTION SYSTEMS

STEP UP PERFORMANCE

Continued from page 204

time seem to be an employe's relationship to his immediate superior. This "first-line" approach of evaluating development is a basic principle on which the program is based.

But use of the Performance Record isn't limited to supervisors. Top management, for example, takes an active interest in anything that results in improved morale, increased production and reduced turnover. This group is concerned with personnel at the policy level. It knows that identifying and developing promising employes, including managerial potential, can occur at all levels in an organization.

Personnel staff is even more involved with an employe program. Take job descriptions, for example. In several organizations where the Performance Record is used, supervisors mention specific Record headings in their job requisitions. Personnel people find this kind of information helpful in guiding recruiting efforts.

The research-minded see the filled-out Record sheets as interesting criteria for justifying expensive selection procedures. Experiments along this line can produce practical results by (1) eliminating needless selection tests, for example, or (2) identifying success traits that were not considered at the selection stage. Future research in Performance Record companies is now being planned. Personnel staff is usually involved with training aspects of a program because employe development and training programs go hand in hand. Likewise, supervisor training in Performance Record procedures is often coordinated through a company's personnel department, often with assistance of an outside consultant.

Program parts. At present, the Performance Record is available in three versions: for (1) hourly employes (2) non-supervised salaried employes (3) foremen and supervisors.

Incident sheets for the three versions while basically similar are clearly different for requirements of each of the three groups. There are separate handbooks for each version. A very important part of this Program is the illustrated booklet explaining it to employes.

Performance Record helps supervisors to: (1) give management a factual basis on which to decide promotions, wage increases, dismissals and specific benefits (2) develop employe morale through stimulating confidence in management's fairness (3) furnish reliable information to release unsatisfactory employes (4) help workers to improve by outlining their strong points (5) find exceptional workers who may be

(*Continued on page* 210)

Kidney for an Atomic Fish

Something the Nautilus, U. S. Navy atomic-powered submarine, must have is chemically pure (ion-free) water. A "kidney" like the one shown above, with MONOBED® ion exchange resins as its innards, keeps water used free of even traces of dissolved salts.

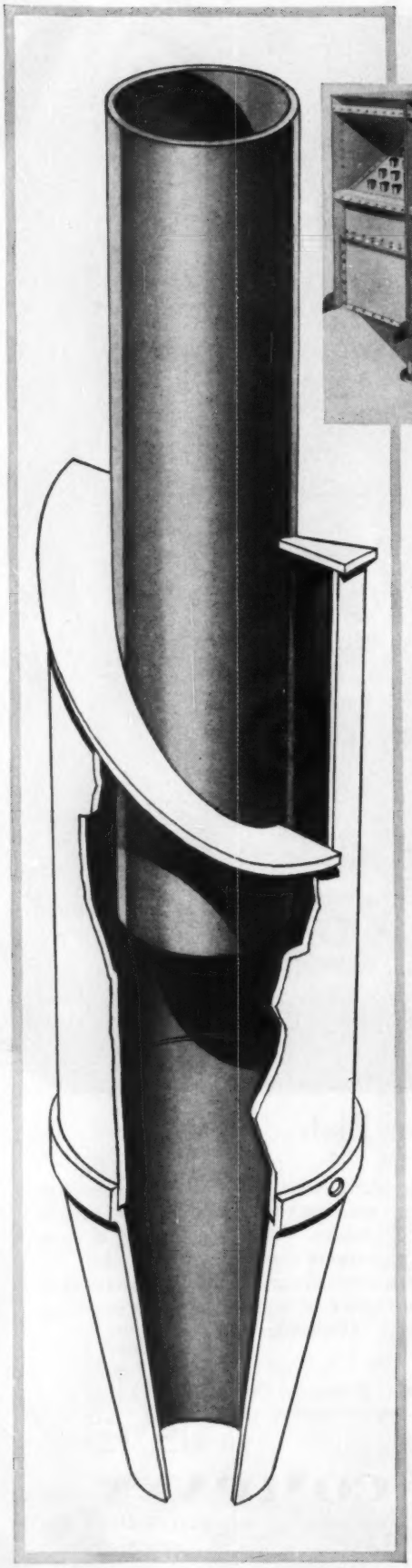
What does this mean to you? It means that if you, too, require water of high quality, from a beaker-full to millions of gallons, for research work or for high-pressure boilers, for steam irons or for industrial processing, you can count on MONOBED ion exchange resins.

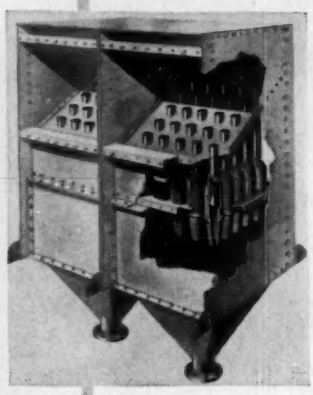
Suppose you don't need the ultimate in ion-free water? Then AMBERLITE® ion exchange resins in conventional deionization units may be the answer. AMBERLITE exchangers may be indicated when you want to soften, dealkalize, or deacidify water—when you want to replace or remove ions in solution . . . economically . . . efficiently.

Ask for "If You Use Water . . .", a 24-page booklet of basic information on the ion exchange treatment of water.

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION, PHILADELPHIA 5, PENNSYLVANIA





Why is the new KOPPERS Mechanical Collector better?

It will pay you to investigate this new Koppers cyclonic type dust collector! You'll find better engineering throughout—better design—because the Koppers Mechanical Collector was developed after years of study and intensive experience in dust collecting problems. This collector is engineered to produce maximum efficiency with minimum pressure drop—and by varying the number and arrangement of individual cyclones, can be designed for any gas volume. We think you'll agree that the Koppers Mechanical Collector *is* better, and Koppers engineers will gladly advise you on how it can help solve your problems. Meantime, for more information on this new Koppers Dust Collector, *write for Bulletin M 42!* KOPPERS COMPANY, INC., *Industrial Gas Cleaning Dept.,* 4808 Scott St., Baltimore 3, Md.

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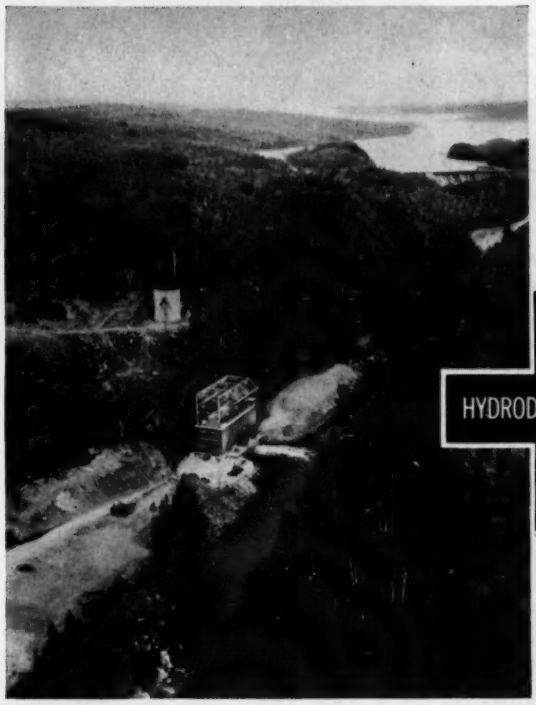
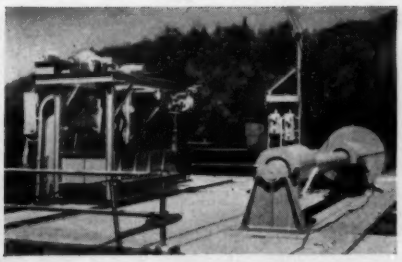
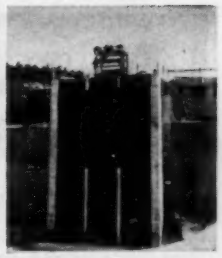
MECHANICAL COLLECTORS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with Fast's Couplings, American Hammered Industrial Piston and Sealing Rings, Aeromaster Fans, Gas Apparatus. **Engineered Products Sold with Service.**



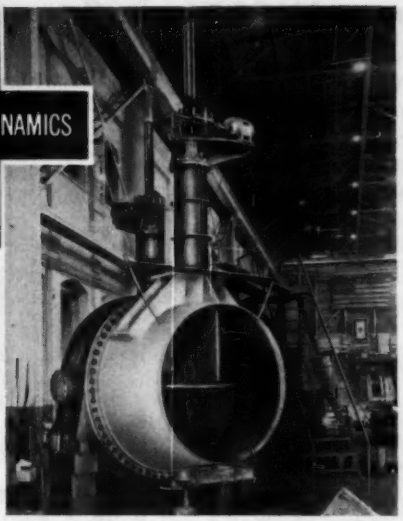
A 16-foot diameter tunnel leads from Ripogenus Dam to the surge tank, from which two penstocks feed the McKay Station turbines. Each turbine has a plate steel spiral case, shop welded in two halves with riveted butt strap connections. SMS accessory equipment is installed at the dam and in the station. Consulting Engineers: Stone and Webster Engineering Corp.





SMS intake gate is installed at the left end of the dam. The 10-foot trash rack rake and self-contained trash car are shown (above) in lowering position above the center rack. Upper left photo shows rear view of the hoist support and trash car, with the 60,000 lb. intake gate hoist in the foreground.

HYDRODYNAMICS



Motor-operated Dow valves, installed at the inlet of each spiral case, provide tight shut-off. Note the streamlined valve disc and housing around operating link connection to the disc.

SMS TURBINES POWER RIPOGENUS EXPANSION

On the upper Penobscot River, Ripogenus Dam had been a storage reservoir for Great Northern Paper Company's downstream power plants since 1916. When studies made in 1950 indicated more power was needed, McKay Station was built. A 4,000-foot, rock-lined tunnel, leading from a new intake in the dam face to the power house below, created a net effective head of 175 feet. Two vertical SMS-Francis turbines, rated at 16,590 hp, were installed, and provision made for the ultimate addition of another unit.

SMS hydraulic equipment was chosen for the entire project. The 18 x 20-foot fixed wheel turbine intake gate is operated by a twin-drum, motor-driven chain hoist. A special log-grapple type trash rack rake keeps the intake free of pulp wood and other debris. Two 108-inch SMS-Dow valves provide shut-off at the turbine inlets.

This Ripogenus hydroelectric expansion typifies S. Morgan Smith's ability to satisfy the complete needs of any project. Over 75 years of world-wide experience in design and manufacture of hydraulic turbines and accessories assures you of equipment that will meet the highest standards. For full information, write S. Morgan Smith Company, York, Pennsylvania.

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AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

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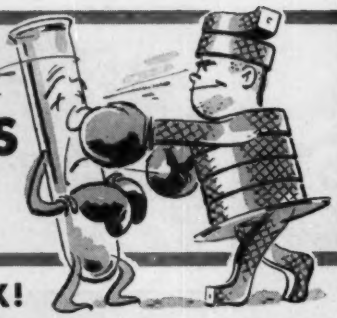

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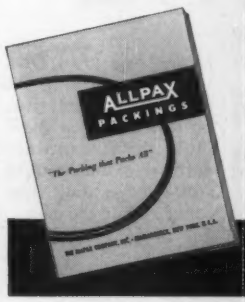
These Allpax Packings shed acids and chemicals the way a duck sheds water. Available in ring, spool or coil form. Both are the result of extensive laboratory research, and contain an acid-resisting lubricant in a special bonding compound. For use on centrifugal and rotary pumps, valve stems, etc. Contact our research department for specific recommendations.



Style No. 4—Made from long strands of asbestos fibres, anti-friction metal particles and scales of high quality graphite. For temperatures up to 600°F.

Style No. 5—Compounded of long, tough strands of blue African asbestos fibres and fine flakes of graphite. For temperatures up to 550°F.

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Shell-Ice being blown into the holds of a Gulf-coast fishing vessel.

Shell-Ice

Below: Bagging Shell-Ice for sale at Oklahoma City. Plant makes 40 tons daily.

Answers the needs of fishermen, truckers, dairymen, poultrymen, hotels, hospitals, restaurants and others for clean, broken ice that can be scooped, shoveled, bagged, or blown through a hose. • Shell-Ice Makers are full-automatic, require little floor space, are highly economical. Built in a multiplicity of sizes. Many in use. Get Bulletin 54 now, and find out what Shell-Ice can do for YOU. Write today to

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FRICK CO.
WAYNESBORO PENNA. U.S.A.

STEP UP PERFORMANCE

Continued from page 206

promoted (6) develop each worker to the extent of his abilities (7) help executives learn how a supervisor judges each worker (8) improve morale by demonstrating an active effort to judge employes objectively (9) discover workers' weaknesses as a basis to plan training for the future.

EDITOR'S NOTE: *Fifth in a series. See "Selecting plant personnel," December 1954, pp 125-127; "Selecting maintenance men," June 1955, pp 117-119; "Aptitude tests," September 1955, 107-109; "Maintenance teamwork," June 1956, 109-111.* More to come.

WATER TREATMENT

Continued from page 87

If you can circulate an inhibited acid solution through the pipe you can do a good cleaning job. Use the same solution as a bath if you take the piping down. Observe the necessary special controls and safety precautions. For a large service-water system with many branches, acid cleaning can be expensive and time-consuming. There are firms that specialize in this work.

Another slow but generally effective chemical cleaning method: continuously add 2 to 5 ppm sodium hexametaphosphate to the water. This usually removes deposits gradually enough so lines don't plug up.

With this method, the water system does not have to be taken out of service. Regular water flow gradually cleans the parts. This method does not protect against further corrosion unless water is close to neutral.

Leaks may show up after cleaning if corrosion has nearly eaten through the pipe.

If you cannot control water conditioning closely, continuously adding small amounts of sodium hexametaphosphate, sodium silicate or some proprietary compound gives a margin of protection. Then irregular control may not cause corrosion or scale formation. Less maintenance may offset the added expense for protective treatment.

Some waters are difficult or expensive to treat. One heat-transfer arrangement for this condition circulates pure condensate in a closed system through a heat exchanger. Connecting piping is then made of suitable corrosion-resistant materials. A duplicate heat exchanger might be necessary if much outage time for cleaning or maintenance were anticipated.

Pure condensate in the circulating

DE LAVAL OPPELLER PUMPS

last longer... cut maintenance costs

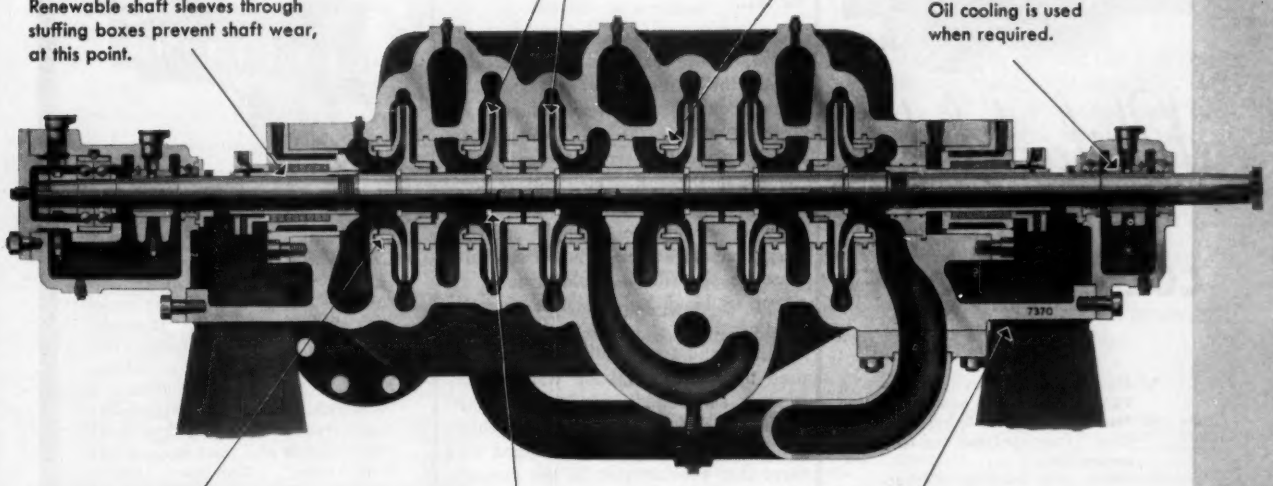
Stages are arranged to reduce differential pressures between stages. This insures permanent sealing at the casing-joint and at interstage diaphragms.

Pairs of back-to-back impellers balance axial thrust. One-purpose thrust bearing carries no radial load, maintains axial alignment.

Labyrinth wearing rings permit safe clearances and reduce wear.

All bearings are ring-oiled, sealed against contamination by water or dust. Oil cooling is used when required.

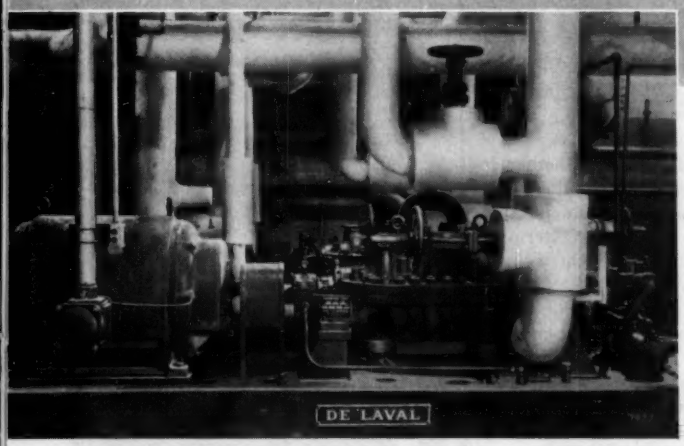
Renewable shaft sleeves through stuffing boxes prevent shaft wear, at this point.



Threaded impeller wearing rings make replacement easy without heating or damage to impellers.

Individual impeller mountings, with split locating rings, make interstage shaft sleeves unnecessary. Impellers can't shift with shaft expansion and contraction.

Casing support insures coupling alignment at any operating temperature.



Here are two De Laval 6-stage Oppeller Pumps used for boiler feed service in an industrial installation.

The design features above show clearly why De Laval Oppeller Pumps stay on the line longer and cost less to maintain. These pumps are used for boiler feed, hydraulic systems, descaling spray, mine dewatering, refinery oil pumping and similar services.

De Laval Oppeller Pumps are available in sizes from 2 to 4 inches and 2 to 8 stages; capacities to 1000 gpm, pressures to 1200 psig and temperatures to 350F.

DE LAVAL *Oppeller Pumps*

DE LAVAL STEAM TURBINE COMPANY

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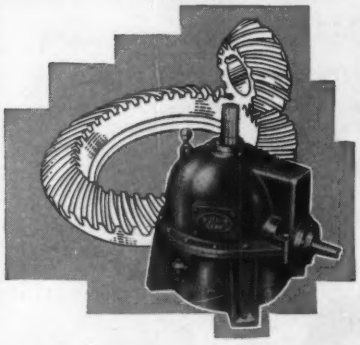
Check these features



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- √ Heavy duty Housing construction.
- √ High dome permits mounting fan directly on unit, with ample clearance below fan blades.
- √ Oversize bearings insure trouble-free operation.
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These widely used Drives are made in six sizes, rated from 15 hp to 75 hp at 1750 rpm motor speed, with Ratios ranging from 2:1 to 9.2:1.

Catalog CT-53 available on request.

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WATER TREATMENT

Continued from page 210

system absorbs oxygen and is then quite corrosive toward iron. Treat it with a chromate or other corrosion-preventing compound. Another way to help prevent corrosion: Maintain high alkalinity with soda ash.

Special corrosion-resistant piping is usually run to and from the large water-using units like hydrogen and oil coolers. This avoids the need for very large heat exchangers and circulating pumps. It also avoids the extra temperature differential of 10 to 30 F in the cooling water that using the heat exchanger necessitates. Hydrogen coolers for generators are designed for cool water since the inlet-gas temperature maximum is usually 104 F. Water from a heat exchanger might be too warm for this.

EVAPORATOR MAKEUP

Evaporator makeup treatment conditions the water so less dirt and scale deposit on heat-transfer surfaces.

Most evaporators are built so inducing rapid temperature changes in the coil cracks off scale. But removal is never complete; some scales are porous or flexible enough so they hardly crack at all. Then evaporator must be shut down while scale is removed by hand, sand blast or chemical treatment.

Filters and zeolite softeners are often used to pretreat makeup water. They remove suspended matter and scale-forming dissolved salts. Dissolved solids are not reduced, but are changed to a form that concentrates in the evaporator instead of forming scale. To keep evaporator clean and maintain its capacity over a long period of time, adjust blowdown so dissolved solids in the evaporator-shell water do not cause priming or foaming.

Set output for a low steady rate to just match boiler makeup requirements. This produces a better-quality product than periodically shutting down for cleaning and then pushing evaporator to get distilled-water supply back to normal.

But there is dispute on whether installing and maintaining filters and softeners save enough to pay for their cost. The type of water determines whether a treatment system is warranted.

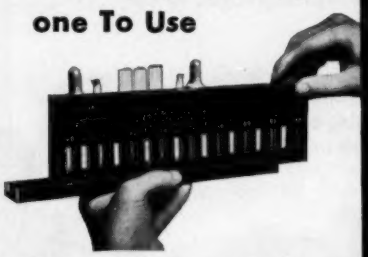
Some stations that have old boilers and turbines take the high-pressure makeup water from the condensate from the low-pressure units having surface condensers. This ordinarily assures a very good quality of evaporator makeup. No further treatment is used except preheating and deaerating.

Deaerating removes oxygen dissolved

TAYLOR COMPARATORS

give *QUICK, ACCURATE* pH, PHOSPHATE TESTS

Complete, Compact Kit—Easy for Anyone To Use



Exact determinations of pH or phosphate content can be made in a matter of minutes with Taylor Comparators. Easy-to-use Taylor Comparators require no additional equipment or chemicals. Everything necessary to make tests comes with each comparator. Compact carrying case also available. No experience or technical knowledge needed. Just fill the middle test tube with the treated sample, move color standard slide across until colors match and read value direct from slide. *Complete water analysis is only a little more detailed with the Taylor Water Analyzer.*

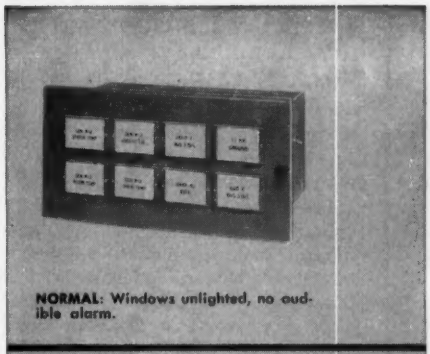
Also, you can determine water hardness quickly, yet with the ease and accuracy of an alkalinity titration, when you use the Taylor Total Hardness Set.

COLOR STANDARDS GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading. There's never any danger of mechanical inaccuracy. Each complete set of standards is mounted in a lightweight, plastic slide . . . eliminates the need for handling fragile, single standards.

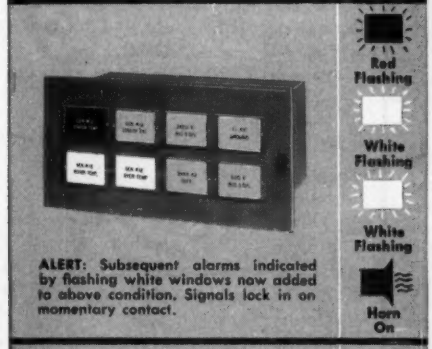
SEE YOUR DEALER for Taylor sets, or write direct for FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Also illustrates and describes complete Taylor line.

W. A. TAYLOR AND CO.
YORK RD. & STEVENSON LANE • BALTO. 4, MD.

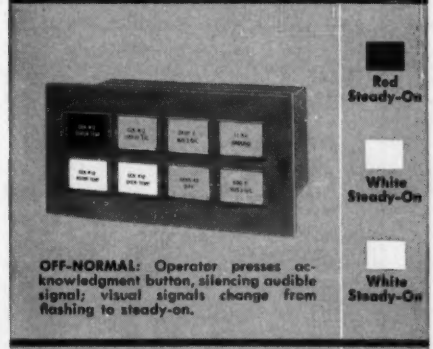


NORMAL: Windows unlighted, no audible alarm.

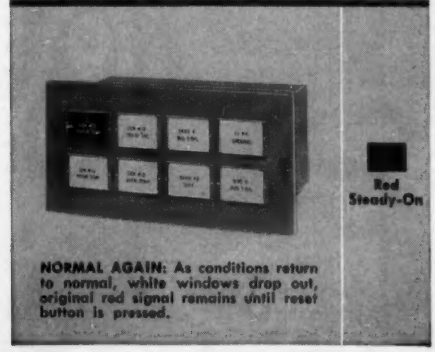
ALERT: Window of first off-normal flashes red; audible alarm. First alarm identifiable with a time difference small as 15 milliseconds between first and following alarms.



ALERT: Subsequent alarms indicated by flashing white windows now added to above condition. Signals lock in on momentary contact.



OFF-NORMAL: Operator presses acknowledgment button, silencing audible signal; visual signals change from flashing to steady-on.



NORMAL AGAIN: As conditions return to normal, white windows drop out, original red signal remains until reset button is pressed.

Panalarm "VS" Annunciator identifies first off-normal from subsequent alarms for rapid corrective action

You gain the control advantages of an audio-visual information system, not just an alarm system, with the Panalarm "50VS" Visual Sequence Annunciator. This is particularly valuable when one off-normal condition will cause a "chain-reaction" of off-normals. Typical Panalarm applications are found in the process industries and among users of automatic machinery.

The original off-normal is clearly identified, enabling the operator to take immediate, corrective action. A considerable saving in down-time can often be effected simply by knowing the original source of trouble.

Panalarm "50VS" is completely flexible in setting up various sequential groups. Any number or combination of signals may be grouped as an independent sequence, and the groupings may be changed at any time by simple jumpers on the terminal block. Signals may be either illuminated nameplate or bullseye indicators, combined with a horn, bell or other audible signal. Signaling is simple and positive. A typical sequence is illustrated on the left.

Write for literature on the "50VS" and other Panalarm Annunciator Systems. A Panellit sales engineer will be happy to make a survey of your production operation to determine whether a Panalarm system can help increase efficiency and safety in your plant.

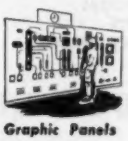
All Panalarm Annunciator Systems are completely modular, permitting future growth and changes. The photographs below illustrate a typical Panalarm Cabinet with illuminated nameplates and the hermetically sealed Panalarm "50" plug-in relay unit. Components throughout are ruggedly built to instrument standards for continuous, dependable duty. Entire Panalarm system is suitable for Class 1, Division 2 installations.

Listed by Underwriters' Laboratories

U.S. Patent No. Re-24,031

Engineered Information Systems for Industry

Panalog Information Systems



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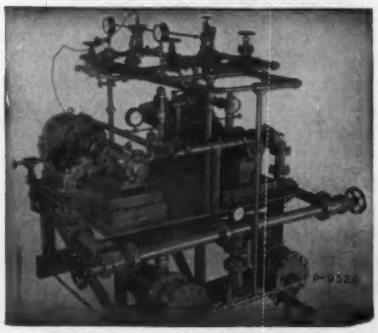

P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

Complete range of sizes and models in both medium and high pressure types . . . more compact than ever! Write for Bulletin 40.

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These and other "accessory items" for every industrial liquid fuel-gas installation. Ask for Brochure No. 10.

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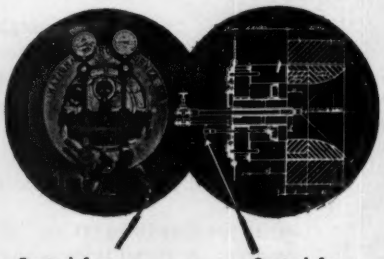
UNIVERSAL REGISTERS with TYPE "SA" OIL BURNERS



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BETTER PERFORMANCE with NATIONAL AIROIL Universal Registers because they have a DUAL FEATURE for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disc control. Both adjustments can be made while the burner is firing.

Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil. Universal Registers with burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin 51.

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STEAM ATOMIZING OIL BURNERS
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LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
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SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

WATER TREATMENT

Continued from page 212

in the makeup water. If the oxygen is not removed it puts more load on the main plant deaerator and may cause corrosion in the evaporator, evaporator condenser, drain piping and in various parts of the main condensate system.

Heating makeup water tends to break down the carbonates and bicarbonates. This releases free CO_2, which deaeration then removes. At the same time, any free CO_2 originally present in the water is removed. CO_2 lowers pH and accelerates the oxygen corrosion rate.

Unfortunately you need prolonged heating at high temperature to get appreciable carbonate breakdown. Much of this occurs in the evaporator rather than in the evaporator preheater. The CO_2 released then contaminates the evaporator vapor. Although most of this gas is removed later in the high heat level condenser or main deaerator, some of it may remain. Operators feel this may be a partial cause for black magnetic oxide deposits found through the condensate and feedwater system and in the boiler.

Carbonates are sometimes removed by adding hydrochloric or sulfuric acid to the makeup water. ($Na_2Co_3 + H_2SO_4 = Na_2SO_4 + H_2O + CO_2$.) Then deaeration removes the CO_2. Sometimes caustic soda has to be added to bring the water to approximately neutral condition. If CO_2 is not removed from evaporator makeup, you may need stainless-steel tubes in the deaerator vent condenser.

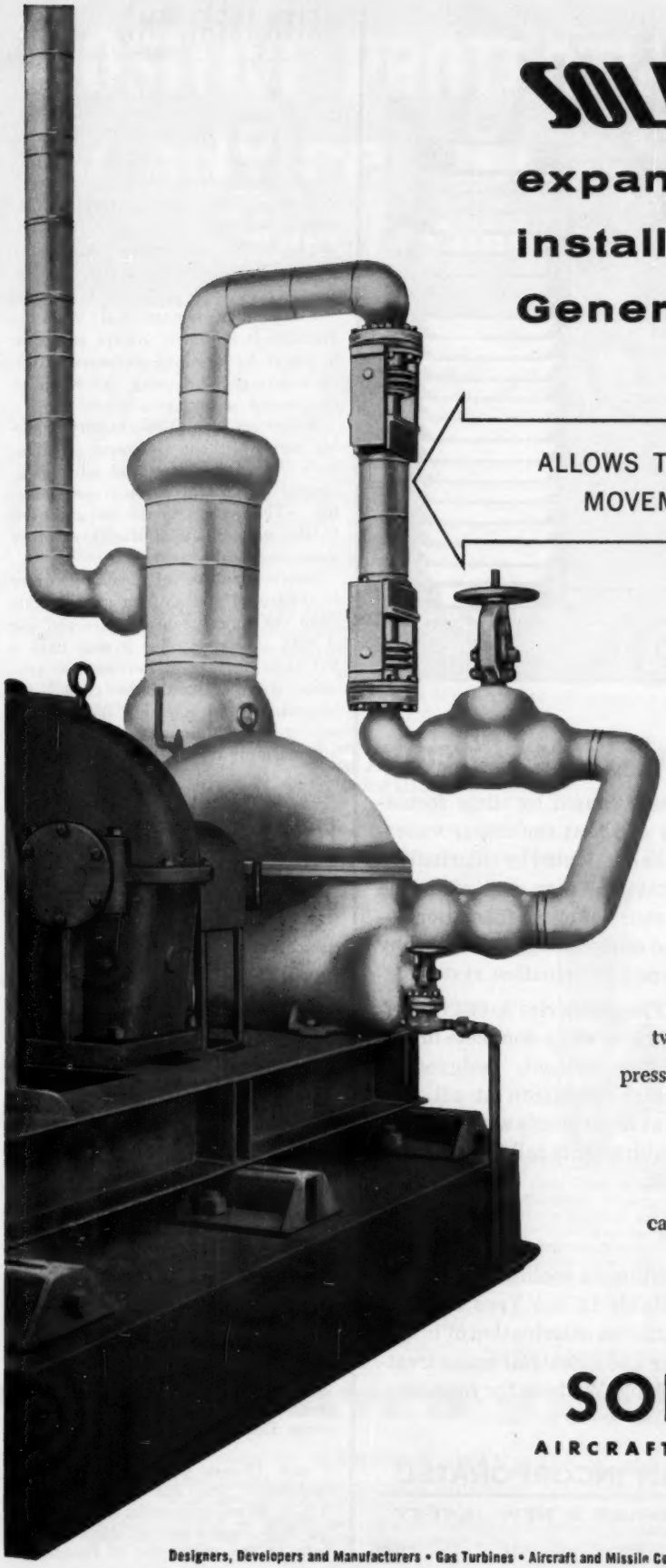
Ammonia in the makeup water probably passes over with the evaporator vapor and concentrates in the main steam-condensate system. Ammonia is very closely bound in the water and deaeration removes only a small portion.

Ammonia has been blamed for removing copper from condenser and feedwater heater tubes, with later deposit in boilers. There the copper may cause boiler metal corrosion because two dissimilar metals immersed in a conducting solution set up an electric current.

Ammonia increases the condensate conductivity. So conductivity recorder readings are affected, and checks for evaporator carryover or condenser leakage are more doubtful. The best remedy for the ammonia problem seems to be to change the source of the water supply if that is possible.

DRINKING WATER

Drinking water must be clear, free from taste or odor and contain no harmful bacteria. The service system water may fill these requirements, but usually



SOLA-FLEX®

expansion joint installation for General Petroleum

ALLOWS TWELVE INCH LATERAL MOVEMENT OF TURBINE

PROVIDING FLEXIBILITY for the steam connection to this turbine assembly was a problem at General Petroleum. The turbine had to be movable to permit installation and take up of drive belts to the compressor unit. A practical solution was found in the use of a 3 in. offset Sola-Flex hinged joint, 42 in. long. The bellows allows a 6 in. movement in two directions—and stands up under rugged pressure and temperature conditions. No matter what kind of expansion joints you need, Solar can build them—ruggedly and economically. Ask for the latest Sola-Flex catalog. Dept. C-49 Solar Aircraft Company, San Diego 12, California.

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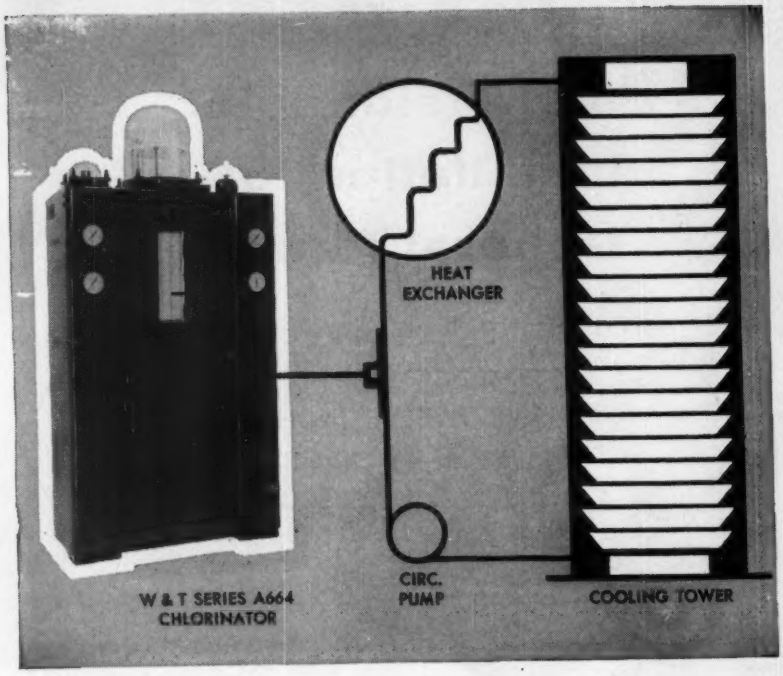
Slime Control...



...Chlorination of Cooling Water Circuits

Heat transfer losses caused by slime formation on condenser and heat exchanger water-side surfaces can be eliminated by chlorination of the cooling water. Water and air-borne organisms—the cause of slime formations—are effectively and economically controlled by Wallace and Tiernan chlorination systems.

The Wallace and Tiernan Series A-664 Chlorinator shown above is one of a complete line of W&T chlorination equipment, designed to give dependable chlorination at all feed ranges. It is used at large plants where cooling water chlorine requirements call for a durable high capacity unit.

We Invite Your Inquiries

Technical information on cooling water chlorination is available in our free booklet, RA-2061-C. Bulletins on chlorination of industrial process water and industrial waste treatment are also available. Write us for your copy.

WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CD-40

WATER TREATMENT

Continued from page 214

chlorination or ultraviolet-ray purification is used too.

A lime-soda softener or other similar system serves to sterilize water. But erratic operation may let the softener pass some water incompletely treated. Subsequent chlorination or sterilization just before entering drinking-water supply lines furnishes an extra margin of safety.

Where treated municipal water is available it is almost always advisable to use it for drinking purposes. High rates may prohibit using this water in the service system as a whole.

Wells may furnish satisfactory drinking water without treatment, particularly if they are deep and adequately capped to prevent surface contamination. The water should be approved by the state Board of Health or other governing health agency.

Another source of drinking water is condensed steam. You can get this from the boiler-steam sampler and use it with assurance. But it may have a flat taste because of low mineral content. And it should be cooled for palatability. In a single boiler plant you need a storage tank to give a water supply during shutdown periods.

LUBE SYSTEM

Continued from page 85

maintenance history (bearing trouble, condition of lubricant and bearing at each change, etc) and then evaluating in light of existing time schedules. In any working schedule, many changes are made over the years before it shapes up in final form.

Then again, no schedule is static. It can't be with changes in lubricants, bearing designs, speeds, temperatures, loads. So to keep any schedule you now have abreast of the times, get to know the lubricants that are continually being developed. Get to know the ingredients, physical and chemical properties, results of performance tests, etc. Oil companies do their share to give you this information.

Harvard University and Massachusetts Institute of Technology will jointly design, build and operate a six-billion volt electron synchrotron to be called the Cambridge Electron Accelerator.

A new 12-acre multi-million dollar air-conditioned plant has been opened by W-K-M Manufacturing Co. The plant occupies a 75-acre site at Missouri City, Texas, a few miles west of Houston.

POSITIVE PROTECTION
AT ANY PRESSURE...
specify Consolidated

TYPE 1551. Cast Bronze Body. For package-type and fire tube boilers, air tanks and other classes of unfired pressure vessels. **Sizes:** ⅜" through 3". **Pressures:** up to 300 psi. **Temperatures:** up to 450° F.

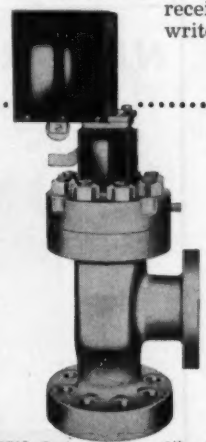
Get protection you can be sure of — whatever your working pressure. Specify Consolidated Safety Valves. Thousands of installations, in both large and small steam generating plants, attest to their complete reliability under all types of service conditions.

Many Consolidated Valves, with bronze body, are widely used for steam, air and water service; many more are installed in power plants as auxiliaries to Consolidated Steel Safety Valves. The cast iron and steel types are proving their dependability daily on low pressure boilers and those operated at super-critical pressures. The five different Consolidated Valves pictured here are representative types but the line is so complete, proper selection is no problem.

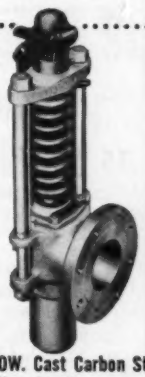
Consolidated Safety Valves are ruggedly built for long service life. Each type incorporates the fewest possible working parts for greatest efficiency. Precision craftsmanship assures positive, tight closing after operation. Through skillful engineering, valve adjustment and maintenance are made simple and easy. All these essentials contribute to outstanding performance, safety and economy.

Just send us details of your particular service requirements and you will receive correct valve recommendations. Or write for Catalog 700A.

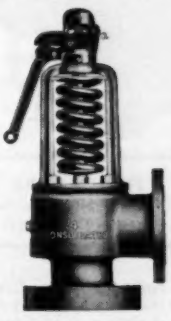
TYPE 1511. Cast Iron Body. An all-purpose safety valve for steam generator service. Cuts cost per pound of steam discharged. **Sizes:** 1½" through 6". **Pressures:** up to 250 psi. **Temperatures:** up to 450° F.



ELECTROMATIC. Carbon Steel or Alloy Steel. An electrically actuated relief valve for boiler service. Operable automatically, manually or cut out of service by setting remote control switch. Supplements spring-loaded safety valves — conserves power and increases efficiency of steam generating plants. **Sizes:** 2½" through 14". **Pressures:** up to 2500 psi. **Temperatures:** up to 1100° F.



MAXIFLOW. Cast Carbon Steel or Cast Alloy Steel. A safety valve with the greater discharge capacity and shorter blowdown demanded by high pressure, high temperature steam generators. **Sizes:** 1½" through 4". **Pressures:** up to 2500 psi. **Temperatures:** up to 1050° F.



TYPE 1415. Cast Steel Body. For water tube boilers, mechanically fired fire tube boilers, accumulators, unfired pressure vessels and pipelines. **Sizes:** ½" through 6". **Pressures:** up to 900 psi. **Temperatures:** up to 900° F.

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.

CONSOLIDATED SAFETY VALVES

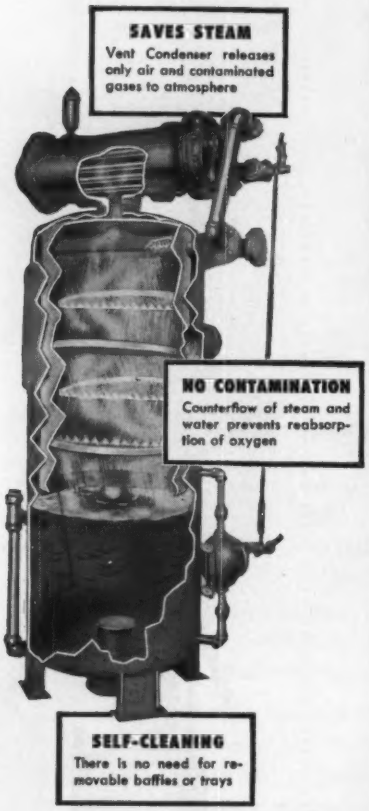
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, CONSOLIDATED SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

Stop Corrosion

in boilers, steam and return lines . . .

with this Stickle deaerating feed water heater


SAVES STEAM
Vent Condenser releases only air and contaminated gases to atmosphere
NO CONTAMINATION
Counterflow of steam and water prevents reabsorption of oxygen
SELF-CLEANING
There is no need for removable baffles or trays

Stickle Baffle Spray Type Deaerating Feed Water Heaters stop corrosion by removing destructive oxygen and carbon dioxide from boiler feed water . . . reduce fuel costs and boiler strain. Vertical and horizontal models. Capacity range: 3,000 to 300,000 pounds per hour. The latest development in more than 50 years of building feed water heaters.

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117 . . . Open Coil Feed Water Heaters

STICKLE STEAM SPECIALTIES CO.
2265 Valley Ave. • Indianapolis 18, Ind.

More FREE LITERATURE

Begins on page 171

8 **Oil-gas burner,** pulsation-type, for dependable combustion under all firing conditions, is described in illustrated 4-p bulletin. Radiant Products Co, Box 729, Canton 2, Ohio.

9 **Refractory material.** Illustrated 4-p bulletin contains descriptions of 13 grades of castable refractory material for many uses. Plibrico Co, 1800 N Kingsbury St, Chicago 14, Ill.

ELECTRICAL EQUIPMENT

10 **Electric plants** for portable, mobile, stationary and emergency service are described in illustrated 8-p bulletin A-428. D W Onan & Sons Inc, Minneapolis 14, Minn.

11 **Wound rotor motors,** in open-type models—both drip and splash-proof; in totally-enclosed fan-cooled and totally-enclosed non-ventilated units, are described in 6-p bulletin 51B8195A. Allis-Chalmers Mfg Co, 952 S 70th St, Milwaukee 1, Wis.

12 **Single phase motors,** 10 and 15-hp all-weather high torque, capacitor-start capacitor-run units, are subject of 4-p bulletin 470-A. Robbins & Myers, Inc, Motor Division, Springfield, Ohio.

13 **Battery charger,** four-circuit automatic unit, is detailed in 4-p bulletin 11-220. The Electric Products Co, 1725 Clarkstone Rd, Cleveland 12, Ohio.

14 **Metal-clad switchgear** with magneblast circuit breakers are described in 8-p bulletin GER-1194. General Electric Co, Schenectady 5, N. Y.

MAINTENANCE EQUIPMENT

15 **Tube cleaners,** tube expanders and other maintenance tools are described in illustrated 8-p bulletin 58. Airetool Manufacturing Co, Springfield, Ohio.

16 **Valve stem packing,** braided asbestos yarns and plastic types, are described in 4-p bulletin 6901. Packing Division, Raybestos-Manhattan, Inc, Passaic, N. J.

17 **Detergent oils.** How to clean sludge out of hydraulic and lubrication systems without shutting down machines is told in bulletin 44. Sun Oil Co, 1608 Walnut St, Philadelphia 3, Pa.

MECHANICAL TRANSMISSION

18 **Miniature couplings** for power transmission are detailed in 4-p bulletin MC-100. Thomas Flexible Coupling Co, Warren, Pa. .

19 **Roller chain** and sprockets are described in 148-p book. Includes sections on stock drives, drive chain, conveyor chain, installation and maintenance, lubrication, sprocket wheels, casings and chain

(*Continued on page* 220)

ERNST

HIGH PRESSURE GLASSES and GASKETS

All sizes to fit your gages and valves

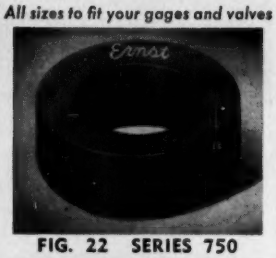

FIG. 22 SERIES 750

FIG. 21 LIP-MOLD

STATE YOUR REQUIREMENTS

All shipments from stock.
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ERNST WATER COLUMN & GAGE CO.
Livingston 6-1400 LIVINGSTON, N. J.

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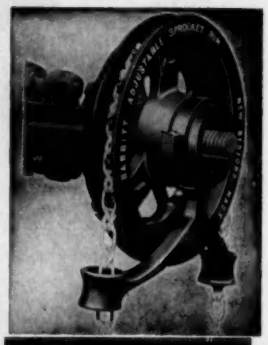


Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

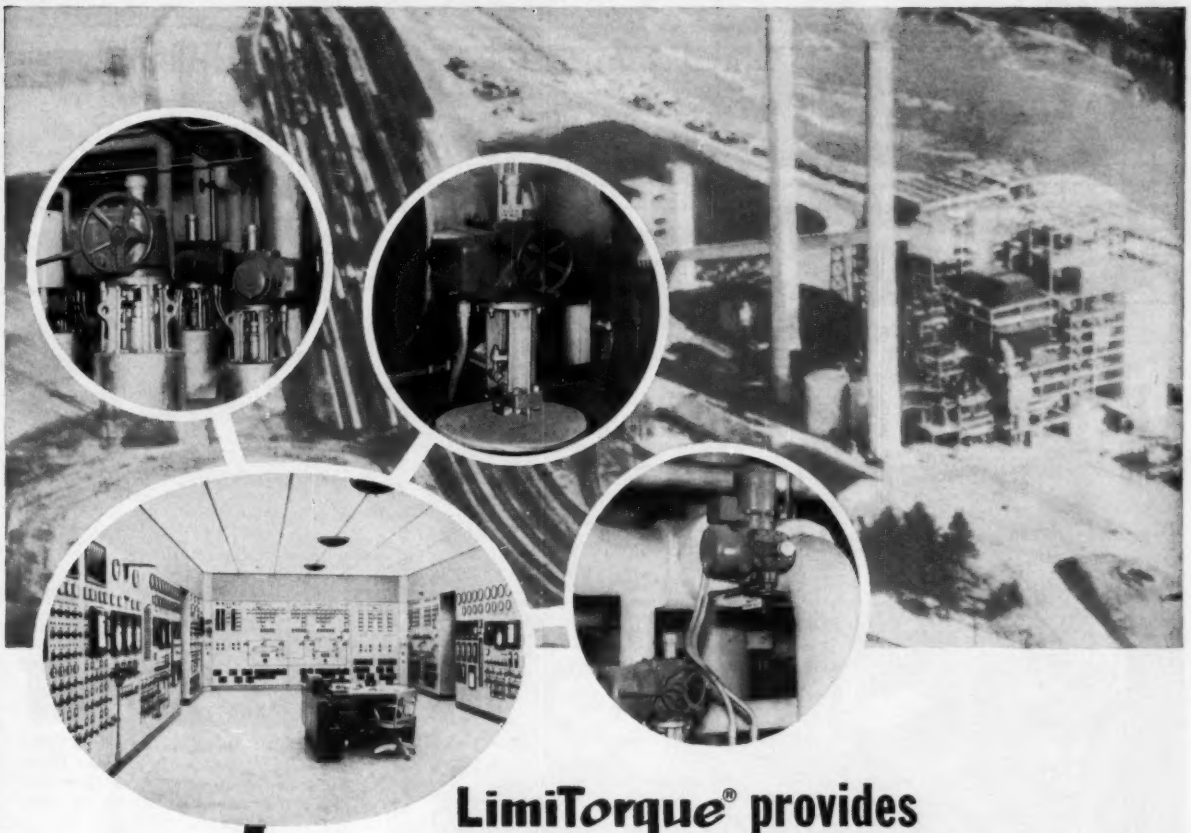
ANY VALVE is readily accessible *from the floor* with low-cost Babbitt Sprocket Rim. Now re-designed for —

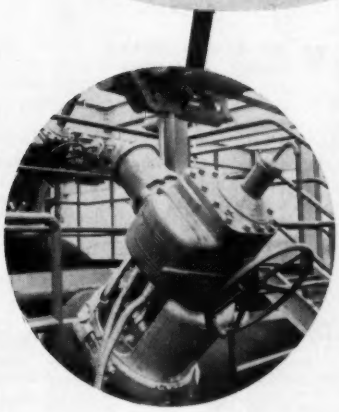
- **Greater strength**
- **Easier, quicker, more solid assembly**

Simplifies pipe layouts, prevents accidents, fits all valve wheels. Your supplier carries complete stocks. Call him — or write for folder and prices.

Babbitt STEAM SPECIALTY CO.

2 BABBITT SQ., NEW BEDFORD, MASS., U.S.A.





LimiTorque® provides push-button operation for Unitized Steam Generation System ...at Cromby Station, P.E. Co.

FROM A CENTRAL CONTROL PANEL ROOM—on intake; circulating pump lines; heating and re-heating; condensate; boiler stop and re-heat lines —the exact status of each vital valve is always readily determined—open, stop, close, all by the mere "push of a button." LimiTorque Valve Controls were chosen by Philadelphia Electric Company for this great station (and their other stations), because of absolute dependability, speed of operation, saving in man hours, and the positive protection of valve seats and stems from possible damage. In addition, because of the "Unitized" layout of this station, any possible difficulties occurring to one unit are isolated from others, thus facilitating maintenance and repair at any time, throughout the station.

A total of approximately 400 LimiTorque Automatic Valve Operators are installed throughout all of Philadelphia Electric's fine power stations. Many of the modern central stations recently built, or now under construction, feature fully Automatic Valve Operation by LimiTorque.

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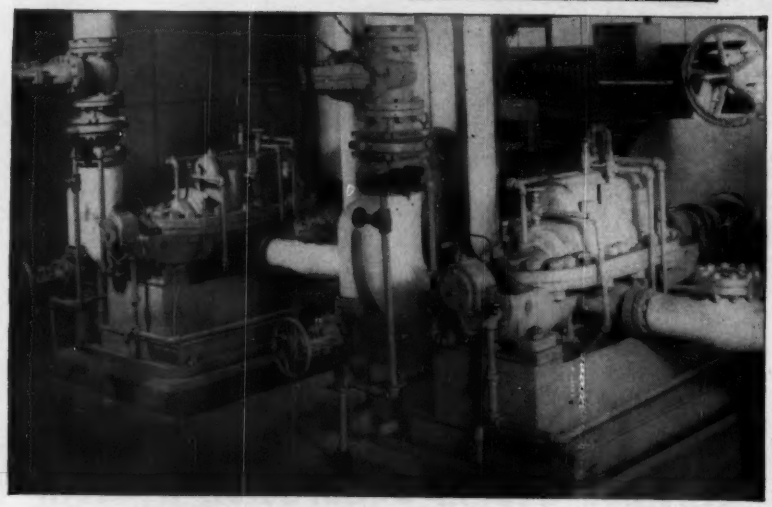
PRODUCTION CONTINUITY

Begins in the Boiler Plant



Warren Six Stage Boiler Feed Pumps installed at a Southern Board and Paper Mill.

Boiler Feed Pumps may look much alike, type for type, but it is well to keep in mind such intangible factors as:

- Experience and integrity of the manufacturer
- Dependability of product
- Know-how, Workmanship, Service
- Maintenance and Repairs
- Lost production due to down-time
- Early replacement because of "tight" original recommendations

It is impossible, of course, to get these items into your "specs," or the supplier into his "quotes," but don't overlook their importance with relation to price, possible future requirements and *production continuity*.

Get your share of "intangibles" . . . specify

WARREN QUIMBY PUMPS

P-84

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.

Warren, Massachusetts

More FREE LITERATURE

Begins on page 171

tighteners, among others. Link-Belt Co, Dept PR, Prudential Plaza, Chicago 1, Ill.

20 **Flexible shafting,** from ⅛ to 1⅝-in. diameter, for either power drive or remote control applications, is subject of 12-p bulletin 570. Stow Mfg Co, 181 Shear St, Binghamton, N. Y.

METERS AND INSTRUMENTS

21 **Recorders and controllers.** Bulletin 1551 includes information about equipment for measuring, indicating, recording and controlling the electro-chemical variables: pH, Redox and conductivity. Minneapolis-Honeywell Regulator Co, Industrial Division, Wayne & Windrim Ave, Philadelphia 44, Pa.

22 **Smoke density** indicator system is described in 4-p bulletin CM-22. Includes data on three recorders that may be used with the system. Electronics Corp of America, Dept CN-4, 718 Beacon St, Boston 15, Mass.

23 **Bi-metal thermometers** are discussed in 4-p bulletin 148. Units can be mounted in any position. Manning, Maxwell & Moore, Inc, Stratford, Conn.

24 **Air-meters,** vacuum gages, flowmeters, electronic standard cells are detailed in 4-p bulletin 136. Hastings-Raydist, Inc, Newcomb Ave, Hampton, Va.

25 **Variable-area flowmeters** for high-capacity services are described in 4-p bulletin 10-A-43. Fischer & Porter Co, 749 Jacksonville Rd, Hatboro, Pa.

VALVES, PIPING, TUBING

26 **Solenoid valves,** 2, 3 and 4-way, are detailed in 32-p bulletin 201. Contains engr info, flow charts, operation and construction details. Automatic Switch Co, 391 Lakeside Ave, Orange, N. J.

27 **Forged steel valves.** Illustrated 16-p bulletin 700 contains details on angle, globe, needle, flow control and check valves. Velan Steam Specialties Inc, 37 S River St, Plattsburg, N. Y.

28 **Control valves** with 3- and 4-way plungers and for fluid power systems to 3000 psi. are described in 16-p bulletin 80300. The Oilgear Co, 1574C West Pierce St, Milwaukee 4, Wis.

29 **Tubing.** Bulletin 142A furnishes condensed data on mechanical and physical properties of seamless and welded carbon steel pressure tubing. Tubular Products Division, The Babcock & Wilcox Co, Beaver Falls, Pa.

30 **Thin-wall tubing.** Bulletin 4 describes tubing in sizes with outer

(*Continued on page* 222)

BALDWIN-HILL
Spun Mineral Wool
MONO-BLOCK

met rigid thermal requirements . . . simplified installation methods at Philadelphia Electric's Cromby Station

- B-H one-block insulation, MONO-BLOCK, simplified inventory of materials. Met requirements for both low and high temperature insulation.
- Light weight, ease of handling, cutting and shaping helped speed application.
- Felted structure of MONO-BLOCK yields to surface projections and irregularities without breakage; easily impaled on studs.
- Provides exceptional stability under severe temperature and moisture conditions.

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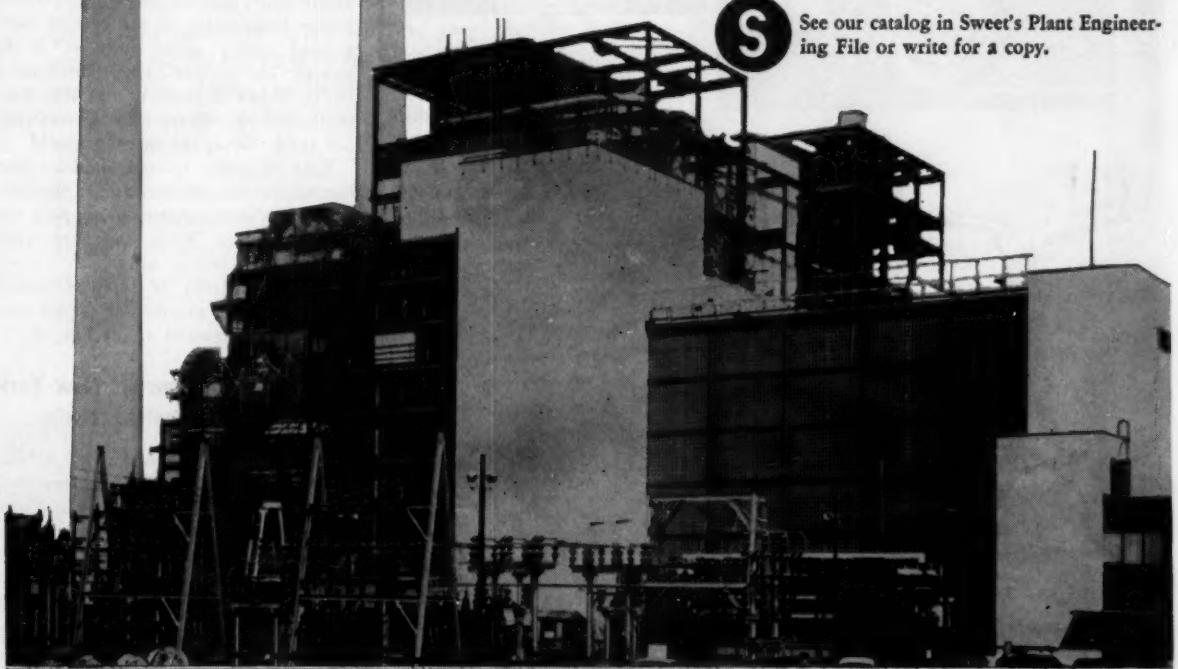
S See our catalog in Sweet's Plant Engineering File or write for a copy.



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B-H Koldboard	B-H No. 52 Asbestos Cement	B-H Calcium Silicate Pipe Insulation
B-H Bond-Tite	B-H Spun Felt Insulation	B-H Mono-Kover Pipe Insulation
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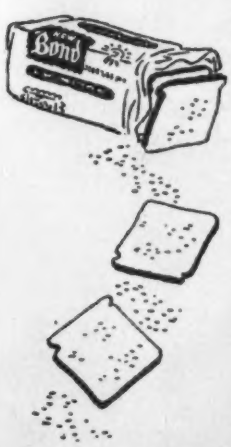
BAKING PLANT RECEIVES 29 YEARS OF TROUBLE-FREE GAUGING



Reliability is a *must* in industrial gauging. That is one reason why Liquidometer quality gauges are specified in a wide range of industries where liquids are stored and measured.

The Liquidometer gauge installation at General Baking Company's Brooklyn plant is typical. It takes close to 7000 gallons of fuel oil per week to run the baking ovens, generate steam and heat the plant. Here, the important job of fuel gauging has been successfully performed by the same Liquidometer Senior gauge uninterruptedly for 29 years.

Dependability, low-maintenance, high readability, safety and ease of installation suit Liquidometers for your liquid gauging needs.

A variety of dial type Liquidometer gauges are available for direct and remote indication. For complete details write Dept. E for Bulletin 463.

LIQUIDOMETER INSTRUMENTS

Liquids worth storing are worth measuring

THE LIQUIDOMETER CORP.

SKILLMAN AVENUE AT 36TH STREET, LONG ISLAND CITY 1, N. Y.

More FREE LITERATURE

Begins on page 171

diameters from ⅝ to 2½ in. and with wall thicknesses of .035 in. and less. Superior Tube Co, Norristown, Pa.

MISCELLANEOUS

31 **Turbine generators,** 1500 to 15,000 kw, are detailed in illustrated 36-p bulletin 1960C-P. Includes info on types and applications, construction, testing and lubrication, sole plates, design, and lagging. Worthington Corp, Harrison, N. J.

32 **Diesels.** Question and answer bulletin is designed to acquaint the reader with basic principles of diesel operation. Illustrated, 24 pp. Cummins Engine Co, Inc, Columbus, Ind.

33 **Automatic coal scale.** Operation, components and auxiliary equipment for two models are described in illustrated 16-p bulletin 0352A. Richardson Scale Co, Van Houten Ave, Clifton, N. J.

REPORTS from the FIELD

Begins on page 156

will not be used to generate electrical power.

The "solution type" reactor uses as "fuel" enriched uranium dissolved in about four gallons of water. Atomic fission takes place in the reactor core, a steel sphere about one foot in diameter. The reactor core is surrounded by an 8x5x5 ft stack of graphite bars that act as a reflector. Dense concrete, 5-ft thick, forms the exterior shield.

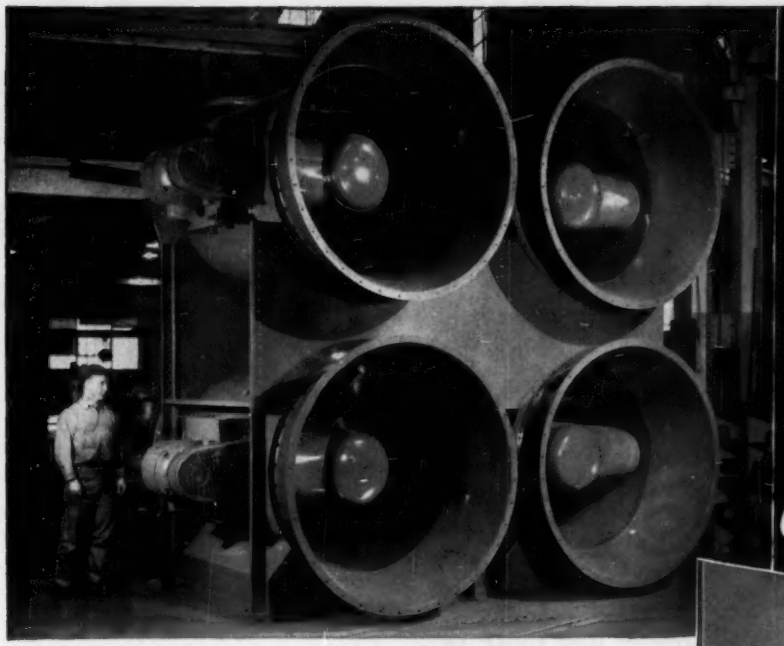
Rate of fission is controlled by four boron rods. When placed near the core the rods absorb neutrons—stopping the fission process. When rods are withdrawn fission begins again.

All radioactivity is confined within the shield. No gaseous or liquid materials are exhausted or discharged.

Committee recommends New York as site for engineering center

► THE PRESIDENTS of ASCE, AIME, ASME, AIEE and AICE have received the report of the Special Task Committee of Fifteen appointed to make recommendations with regard to the site of the Engineering Societies Center. Action is to be taken by the several governing boards. The recommendations, in part, follow: (1) The Engineering Societies Center be located in New York City. (2) The 39th-40th Street site be continued in use as the site of the Center. (3) If rebuilding in that area proves impracticable, a comparable site should then be sought in midtown New York.

(*More Reports, Calendar on p* 224)



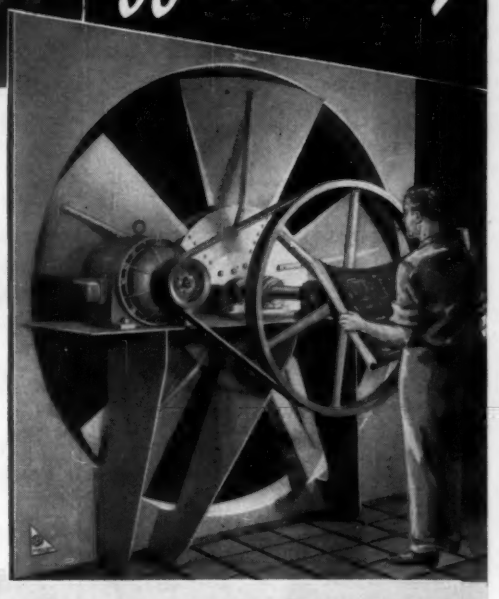
MOVE BOILER ROOM HEAT OUT *efficiently*

"Buffalo" 4-Fan Axial Flow Package Unit

WITH "BUFFALO" AXIAL FLOW FANS

Ideal for cooling because of their high outlet velocities and high efficiencies for which they are noted, "Buffalo" Axial Flows are doing outstanding jobs in boiler rooms. They are light and compact. They are well-suited to operate against pressures up to 3". And they may be duct-mounted for distribution of hot boiler room air to other parts of the plant. The multiple unit package above is cooling a large power plant boiler room. Write for Bulletin 3533.

BOTH THESE FANS are built to the same high "Q" Factor* standards as the well-known "Buffalo" Mechanical Draft Fans serving many of the country's finest power stations — your assurance of the best when you specify "Buffalo".



"Buffalo" 96" Package Propeller Fan

...WITH "BUFFALO" PACKAGE PROPELLER FANS

These have all the advantages of propeller fans as to cost and simple installation — plus the ability to move large quantities of air, even against static pressures as high as 1". Unusually efficient and sturdily built, "Buffalo" Propeller Fans embrace a huge range of sizes up to 144" wheels to handle as high as 250,000 cfm. These fans are proving well-suited to lowering ambient temperatures, successfully keeping large boiler rooms cool and comfortable. For complete details . . . write for Bulletin FM-315.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

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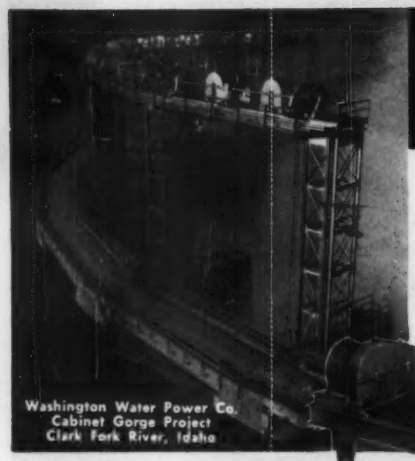

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MURCO Gate Hoists are designed and built in a wide range of capacities—for any size power dam—from less than one ton to over 100 tons . . . from the smallest hand operated to the largest motor operated gate hoist. Back of every MURCO Gate Hoist is over 70 years of designing and building, and from this experience we have accumulated designs and patterns that may fit your requirements. In planning gate hoists we suggest you write us before your plans for the project as a whole are completed.

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There's still nothing simpler or more efficient in power line service than this Wilcox Self-Sealing Gasket which has served industry so well over the years. The U-shaped metal outer cover is packed with a resilient filling (usually rubber or asbestos). Pressure exerted on this elastic filling forces it into the cover, putting force against the adjacent flange surfaces. Thus, internal pressure that tends to blow ordinary gaskets makes the Wilcox Gasket tighter in the joint. Available with covers of copper, lead, tin, aluminum, monel, stainless steel, etc. in all sizes—standard or special.

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REPORTS from the FIELD

Begins on page 156

Underwater cables now link both Michigan peninsulas

► FOR THE FIRST TIME in history the upper peninsula of Michigan is electrically linked to the lower part of the state. In June, Consumers Power Co laid four underwater cables across the 4-mile wide Straits of Mackinac. These cables are designed to carry electric power at 46,000 v to the 350,000 residents of this region. Manufactured by The Okonite Co, Paterson, N. J., the paper-insulated, lead-sheathed, armored power cables are about 2.1 in. diameter.

Calendar of Events

Aug 11-15—American Society of Mechanical Engineers, 1st National Conference on Applied Heat Transfer. Pennsylvania State University. Details from ASME, 29 W 39th St, New York 18, N.Y.

Sept 17-21—Instrument Society of America, 11th Annual International Instrument-Automation Conference and Exhibit. New York Coliseum. Further information from ISA, 1319 Allegheny Ave, Pittsburgh 33, Pa.

Sept 20-22—Institute of Power Engineers, Annual Convention, Royal Alexandra Hotel, Winnipeg, Manitoba, Canada. Details from IPE, 239 Linden Ave, East Kildman, Winnipeg 5, Manitoba, Canada.

Sept 24-25—Steel Founders' Society of America, Fall Meeting. The Greenbrier, White Sulphur Springs, W. Va. Details from SFSA, 606 Terminal Tower, Cleveland 13, Ohio.

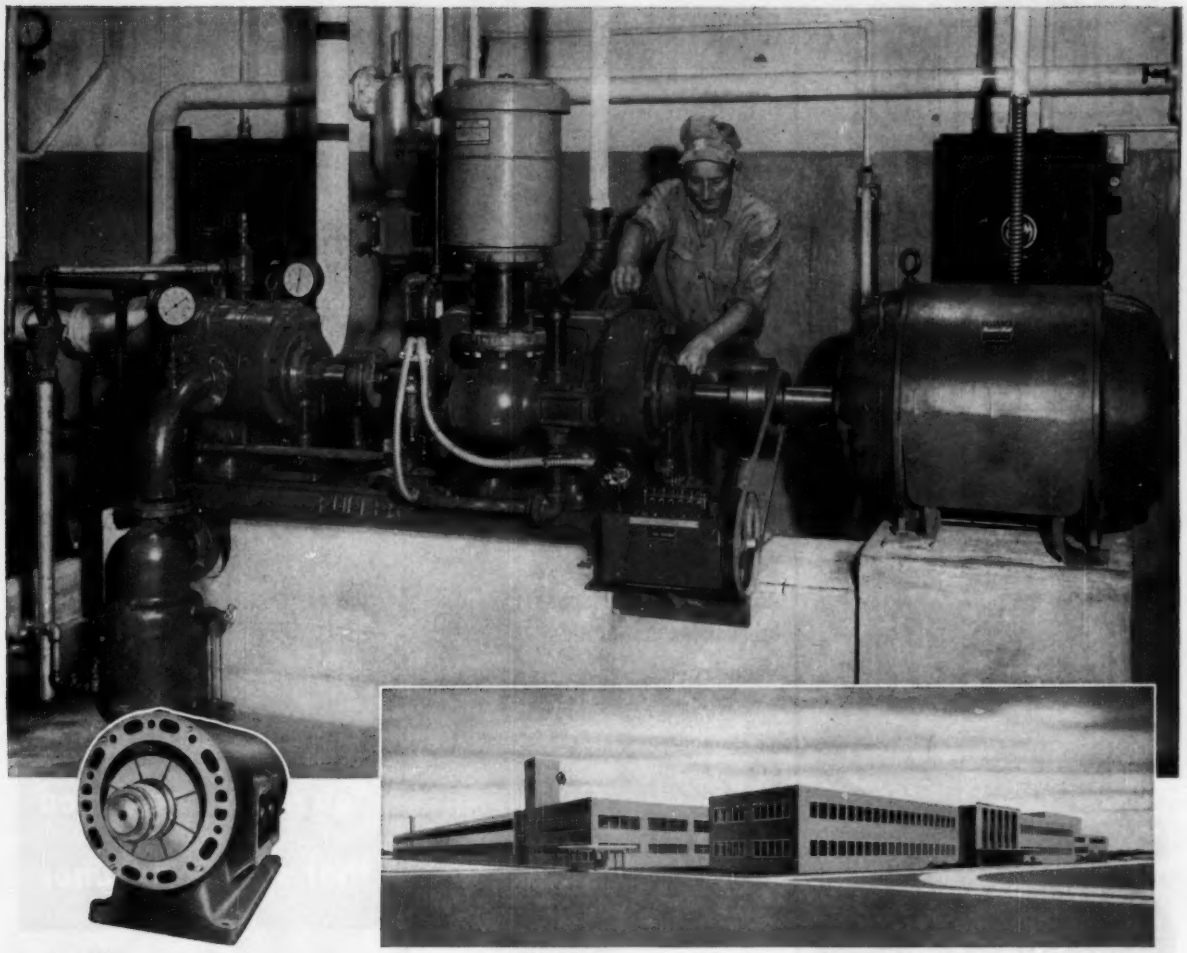
Sept 25-28—Association of Iron and Steel Engineers, 1956 Iron & Steel Exposition and Annual Convention. Public Auditorium, Cleveland, Ohio. Complete information obtainable from AISE, 1010 Empire Bldg, Pittsburgh 22, Pa.

Oct 1-5—American Institute of Electrical Engineers, Fall General Meeting. Morrison Hotel, Chicago. Details from AIEE, 33 W 39th St, New York 18, N.Y.

Oct 8-10—American Society of Mechanical Engineers and **American Society of Lubrication Engineers,** 3rd jointly-sponsored Lubrication Conference. Chalfonte-Haddon Hall, Atlantic City, N.J. Details from ASME, 29 W 39th St, New York 18, N.Y. or from ASLE, 84 E Randolph St, Chicago, Ill.

Oct 8-12—American Society for Metals, 38th Annual National Metal Congress and Exposition. Public Auditorium and Exhibition Hall, Cleveland. Details from ASM, 7301 Euclid Ave, Cleveland 3, Ohio.

Continued on page 226)



Modern, reliable air power for a modern, efficient plant

When Electric Controller & Manufacturing Company, Division of Square D Company, Cleveland, Ohio, designed and built its new four and one half million dollar plant, they had their sights set on economical production at high-level efficiency.

One of the items given serious consideration was the supply of compressed air, a considerable quantity of which is used throughout the plant. Fuller Company is justifiably proud to be associated with such a plant in being awarded the contract to furnish a Fullery Rotary Two-stage compressor as the main source of general plant air . . . a modern, efficient compressor for a modern, efficient plant. This machine has a capacity of 281 c.f.m., at 100-lb pressure.

Fuller Rotaries do a very big job no matter how tough the going. It's a job that, more and more, is being multiplied throughout all industry, these machines having gained wide acceptance as an efficient, reliable source of air power.

The key to Fuller's long life, and smoother operation, is *rotary motion*, which provides large capacity in relation to size, simple direct drive from motor or internal-combustion engine, minimum of working parts, air-flow free from pulsations, lack of vibration, continuous service with minimum supervision and maintenance. Installation in cramped quarters or on ordinary flooring is simple and practicable.

For a full description of Fuller Rotary Compressors and Vacuum Pumps, we would like to send you a copy of Bulletin C-5A. Write for your copy today.

FULLER COMPANY

126 Bridge St., Catasauqua, Pa.

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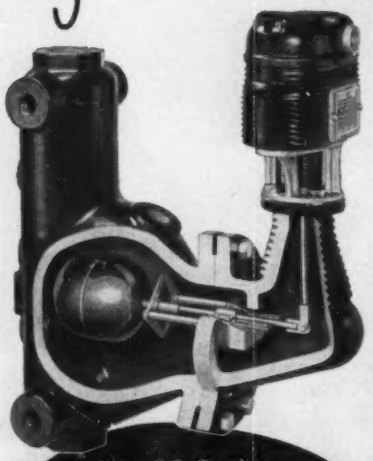
C-290
3425

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

McDonnell goes High Pressure



No. 92 Series
Pump Control, Cut-off and Alarm Switch
For pressures to 250 psi.

- Repulsion magnetic switching—for positive opening *and* closing.
- Unprecedented heat dissipation—okayed for 75° C. (167° F.) wiring at terminals.
- Extra generous clearances in float chamber.
- Operating levels unaffected by pressure changes.
- McDonnell quality throughout.
- Four models—with or without integral water column.

Use this new 92 Series for controlling boiler feed pump, or electric valves; for low water cut-off or alarm; for tank level control, etc. For lower pressures—to 150 psi.—use companion 91 Series. New catalog has full engineering data.

Write for Bulletin L-123

McDONNELL & MILLER, Inc.
3506 N. Spaulding Ave. • Chicago 18, Ill.

Doing One Thing Well

McDONNELL
Boiler Water Level Control

REPORTS from the FIELD

Begins on page 156

Oct 22-26—National Safety Council, 44th National Safety Congress and Exposition, Conrad Hilton, Congress, Morrison and LaSalle hotels, Chicago. Further information from NSC, 425 N Michigan Ave, Chicago 11, Ill.

Oct 31-Nov 2—Society for Experimental Stress Analysis, 1956 Annual Meeting and Exhibit. Deshler-Hilton Hotel, Columbus, Ohio. Details from SESA, Box 168, Cambridge 39, Mass.

Nov 26-30—American Society of Mechanical Engineers, 22nd National Exposition of Power and Mechanical Engineering. New York Coliseum. Further information obtainable from ASME, 29 W 39th St, New York 18, N. Y.

ASME and ASLE to sponsor lubrication conference

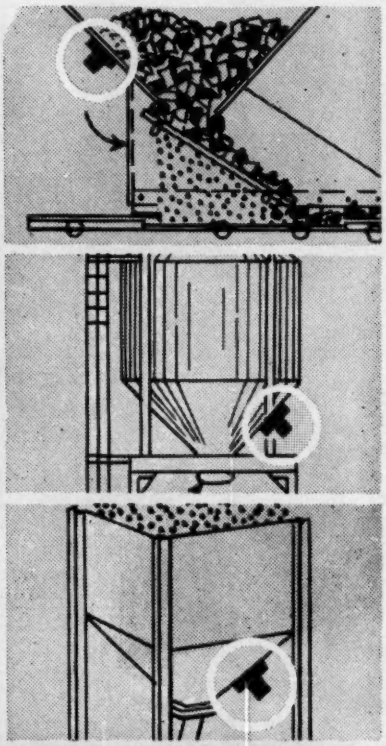
► PRELIMINARY PLANS for the third jointly-sponsored Lubrication Conference indicate that special attention will be given to problems involved in lubrication of nuclear power equipment. Eight research papers in this field range from studies of fluid metal as lubricants to the effect of radiation on petroleum products.

Another highlight of the Conference will be a "reporter-type" session devoted to papers on hydrodynamic lubrication. Other subjects to be covered include boundary lubrication and lubricants. Approximately 22 research and development papers will be presented.

The Conference will be held October 8-10 at Chalfonte-Haddon Hall, Atlantic City, N. J.

Crane Co and **Vitro Corp of America** have entered into a joint operation to produce thorium, rare earths and heavy minerals from monazite, as well as rutile, ilmenite, zicron and kyanite.

"Do you think there's any hope that we'll be replaced by automation?"



You really *don't* need that *sledge hammer*

to keep coal moving smoothly through storage and into your fire box. The *engineered installation* of Cleveland Vibrators on...

Chutes Hoppers
Bunkers Bins
Tubes...

will eliminate delays and save man hours by providing a steady flow of fuel, automatically.

Write for detailed information on our complete line of bin vibrators for the power industry.

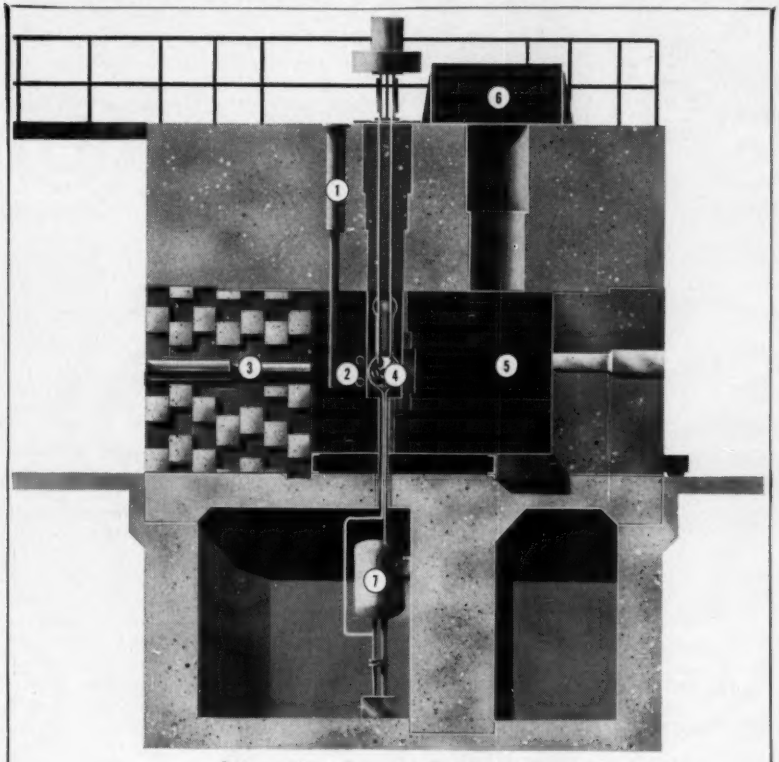
Air or Electric
Portable or Permanent
Silent or Standard

2824 Clinton Avenue • Cleveland 13, Ohio

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Aqueous, homogeneous type nuclear reactor being built for Japan

The first nuclear reactor for the Far East is being built by ATOMICS INTERNATIONAL for the Atomic Energy Research Institute of Japan. The reactor will be located near Tokyo. When the reactor starts operating early in 1957, a full program of research into the peaceful applications of nuclear energy will begin. This program includes the production of radioisotopes, studies in neutron activation, neutron diffraction, radiation effect on materials and training in reactor techniques.



Solution Type Research Reactor for Japan.

1 – Vertical thimble
2 – Pneumatic tubes
3 – Beam Tubes
4 – Central exposure facility
5 – Horizontal thermal column
6 – Vertical thermal column
7 – Gamma radiation area

At a rated power of 50 kilowatts, this solution type reactor will produce a peak thermal neutron flux of 1.7 x 10^{12}/cm^2 sec. Equipped with a five foot graphite thermal column, it will provide an extensive source of slow neutrons. Additionally, the room beneath the reactor housing the gas handling system has been designed to provide neutron-free gamma irradiation. This facility, ideally suited for biological and chemical experiments, will provide 50,000 curies of radioactivity in Xenon and Krypton gases circulating in the system.

The core of the reactor is a stainless steel sphere with a diameter of approximately 12 inches, filled with a uranyl sulphate solution. The fuel investment is approximately 1000 grams of Uranium^{235}. The reflector around the core consists of graphite stacked in a rectangular steel tank 5 feet high, 5 feet wide and 8 feet long. Appropriate holes for experimental facilities and instrumentation are located in the graphite. Five feet of dense concrete provides a shield around the reflector tank.

Instrumentation control is provided by two types of sensing elements which give neutron level information. In the power range up to approximately 1 watt, two fission chambers are employed. In the power range of approximately 0.1 to 50,000 watts, two gamma compensated ionization chambers are used. One of these chambers is fed into a shutdown channel and an electrometer which in turn sends a signal to the power level recorder. Power level is automatically maintained by feeding an error signal from the level recorder to a servo-amplifier which drives the regulating rod motor in the proper direction to correct error. The other ionization chamber feeds a logarithmic amplifier, and period shutdown circuit.

The core cooling system consists of a closed, recirculating system using demineralized light water. The core cooling loop includes about 90 feet of stainless steel tubing, the associated pump, valves and piping, and a heat exchanger to transfer the heat to a secondary cooling system.

ATOMICS INTERNATIONAL, a division of North American Aviation, Inc., is a major reactor builder—experienced in the design, construction and operation of nuclear reactors for research and the production of power. A reactor similar to the one scheduled for Japan has been installed for the Armour Research Foundation of the Illinois Institute of Technology in Chicago. It is one of several in-action nuclear reactors designed and built by ATOMICS INTERNATIONAL.

If you are interested in any phase of reactor technology, ATOMICS INTERNATIONAL is staffed and equipped to serve you. Please write: Director of Technical Sales, Department PW-N4, ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

PIPING LAYOUT IS SIMPLER with Gentile* FLOW TUBES

...THEY NEED SO LITTLE ROOM

Gentile Flow Tubes are impact type head meters for use as differential producers.

They are short and they need only minimum straight runs entering and following, and can be installed at practically any accessible point where flow conditions are reasonably steady.

Flow Tubes are furnished with individual head capacity curves, and for unusual piping arrangements, calibration curves for simulated conditions can be furnished.

Guaranteed

- Accuracy
- Minimum Head Loss
- Reproducibility

*GEN-TIL-LY

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE UNION, N. J.

AUTOMATIC VALVES • CONTROL VALVES • SAFETY VALVES • FLOW TUBES

BOOKSHELF

Accident Prevention Manual for Industrial Operations. *Third Edition. By National Safety Council. 1341 pages, 6 x 9, cloth, illust. $11.75 to members, $13.50 to others. National Safety Council, 425 N Michigan Ave, Chicago 11, Ill.*

This large, revised edition was prepared by engineers and other staff specialists of the National Safety Council, collaborating with qualified individuals in the professions and industry.

Volume contains 43 sections of industrial safety principles and background, technical data and exposition of techniques for eliminating unsafe practices and unsafe conditions. It is a technical reference intended to relate to all of industry. The authors attempt to state the basics of a technique or device before proceeding to advanced analysis or presentation of detailed data. For example, the section on boilers covers purchase and installation, auxiliaries, safety appliances, placing in service, fuels, operation, taking out of service and emergencies in the boiler room.

The volume is in no sense a code or collection of codes. But it refers to and mentions many standards.

Contents include 18 new subject sections plus expanded treatment of material in previous editions.

New sections include safety organization, removing the hazard from the job, human behavior and industrial safety, hoisting apparatus and conveyors, local exhaust systems and ventilating and safety engineering tables.

Revised sections of special interest to men in the power services include plant construction and maintenance, handling and storage of materials, ropes, chains and slings, principles of guarding, welding and cutting, table of chemical hazards, boilers, pressure vessels, refrigeration equipment, electrical hazards, fire prevention and accident records.

Atoms for Peace (1955). *By David O Woodbury. 5¾x8¼, 259 pp, illust, $3.50. Dodd, Mead & Company, 432 4th Ave, New York 16, N. Y.*

A philosophical book, only incidentally technical. The author is more concerned with the effects of nuclear energy in the future than with the present technical problems of making it work. Hence there is more of speculation than practical fact.

In 39 very brief chapters he touches on such speculations as atomic power for bombs, power, marine vessels, automobiles and aircraft. He outlines problems of safety and waste disposal. Other brief mentions include the nature and use of isotopes in medicine, agriculture and industry.

Construction by Carrier Corp of a $6 million west coast plant for production of air-conditioning equipment, furnaces and water heaters will begin this year. The new facilities will be located on a 68-acre plot at Puente, Calif., 18 miles east of Los Angeles.

World's largest fleet of coal cars
62,000 coal cars, with 8,000 more on order, insure dependable deliveries from mines on the C&O
Chesapeake and Ohio Railway
WORLD'S LARGEST CARRIER OF BITUMINOUS COAL
For dependable deliveries of top quality coals, contact coal producers on the C&O. And if you need help in meeting your own particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Expanding, Modernizing or Constructing New Power Facilities?

Let Pritchard's Knowledge and Experience Go to Work for You

When planning expansion, modernization of your present power plant or construction of new facilities, the first step in the right direction is to consult with Pritchard

Why Pritchard? Because Pritchard has the experience so necessary to the successful completion of such a project. Pritchard people *know* the power industry from years of experience in designing and building power plants. What's more, Pritchard offers you the popular Single Responsibility Contract, which benefits you four ways. 1. You know the cost before the job begins. 2. You have a firm guarantee of operation and efficiency of the completed plant. 3. You realize greater savings from coordinated purchase of materials. 4. You realize a faster return on your investment because of earlier completion date.

Before you plan your next expansion, modernization or construction project, consult Pritchard.

J. F. PRITCHARD & COMPANY
4625 Roanoke Parkway Kansas City 12, Mo.

Pritchard's ability to enlarge and modernize power plants has been proved!

The giant power plant for National Petro-Chemicals Corporation's Tuscola, Illinois plant is just one of many successful Pritchard installations.

The plant was designed, engineered and built by Pritchard under the popular Pritchard Single Responsibility Contract, working with the client's staff.

This experience is available to you!

When you plan to expand, modernize or construct new facilities in your power plant, contact Pritchard *first.*

LIKE TO HAVE A PICTURE STORY OF TUSCOLA?

Just write today on your company letterhead for your FREE copy of the TUSCOLA BROCHURE. In it you will find a picture story of the world's largest petro-chemical plant, including the power facilities.

INDUSTRY'S PARTNER FOR PROGRESS

J.F. Pritchard & Co.
ENGINEERS • CONSTRUCTORS
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Kansas City 12, Mo.

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES
BOSTON, CHICAGO, BUFFALO, HOUSTON, NEW YORK, PITTSBURGH

APPOINTMENTS

Corporation executive changes

Consolidated Electrodynamics Corp: Hugh F Colvin, president. **Oxy-Catalyst, Inc:** Van Horn Ely Jr, president; Eugene J Houdry, chairman of the board. **Water Service Laboratories, Inc:** Henry Robins, executive vice-president. **Arthur D Little, Inc:** Howard O McMahon and William A W Krebs Jr, vice-presidents. **Vapor Heating Corp:** A J Loose, vice-president.

Philadelphia Electric Co: Milton I Allen, vice-president, sales. **Raybestos-Manhattan, Inc:** H H Burrows, senior vice-president of rubber sales division; R B Hazard, vice-president and sales manager rubber and packings. **H K Porter Co, Inc:** Lawrence L Garber, vice-president, production. **The Mercoid Corp:** W K Stauffer, vice-president, Eastern area.

Engineer changes

Schutte and Koerting Co: LeRoy S Harris, manager of research and development dept. **Western Precipitation Corp:** Norman M McGrane, chief technical engineer. **The New York Air Brake Co:** Karl W Galliger, director of engineering. **Ford Instrument Co:** George A Crowther, chief engineer.

Canadian Westinghouse Co, Ltd: H N Muller Jr, chief engineer. **C W Davis & Son, Inc:** D W Lowe, chief engineer. **Fort Wayne Corrugated Paper Co:** Phillip Ziegler, power engineer. **Alco Products, Inc:** R Tom Sawyer, consultant on engineering and development problems.

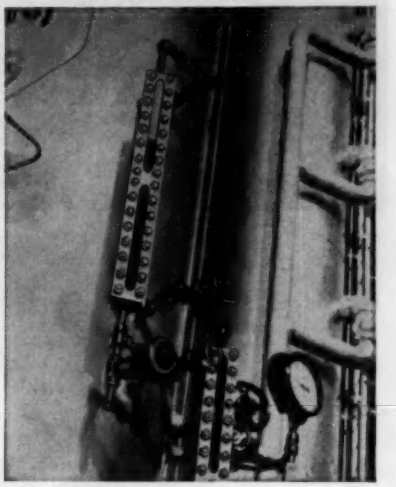
New sales managers

Joy Manufacturing Co: John P Cartwright, industrial sales. **Metal & Thermit Corp:** A James Fisher, general sales manager. **The Youngstown Sheet and Tube Co:** R P Broadhurst, Chicago district; C Hix Jones, Dallas district. **The Babcock & Wilcox Co,** boiler division: Seth M Snyder, Charlotte, N.C. district. **Struthers Wells Corp:** John W Pike, Eastern district. **Crane Co:** Thomas D Kelly, Midwest district; Darrell R Nordwall, East Coast district; Charles H Lovelace, valve and fitting sales. **The Fairbanks Co:** J E Bates, New England district.

New district offices

A W Cash Co: at 115-117 S Main St, Decatur, Ill. **Graver Water Conditioning Co:** at Room 707, 6 Beacon St, Boston, Mass., William A Homer, manager. **The Trane Co:** sub-office of Denver, Colo. office, at 3217 Silver St SE, Albuquerque, N.M., Gary Mays, manager. **Hills-McCanna Co:** at 7046

BLACK WHITE VISIBILITY



Factory Mutual Approved

JERGUSON Series #5 Reflex Gages Give you up to 19¼" of Clear Visibility

THE sharp black-white contrast of the level of any color liquid, against the empty space above, in Jerguson Series #5 Reflex Gages, makes possible highly accurate liquid level readings even where lighting is poor.

Gages are made of any material to withstand corrosive liquids. Glasses are specially treated with Jerguson Anti-Fouling Compound to give clearest visibility over a long period. Special illuminators available.

Series #5 Low Pressure Reflex Gages are available in sections to give you any desired total gage length. Materials used are selected to conform to or exceed the rigid requirements of A.I.S.I., A.S.T.M., and/or A.P.I.-A.S.M.E. specifications.

You can depend on Jerguson Gages. Write today for full information on Series #5 Gages, or for help on any gage problem.

JERGUSON
Gages and Valves for the Observation of Liquids and Levels
JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
Jerguson Trent Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

A LIGHT THAT NEVER FAILS

Now Possible With Peabody Rifled Tile For Gas Fired Burners

Lost ignition need no longer worry users of gas-fired burners, even under the most adverse firing conditions. The new Peabody tile, specially designed and rifled in direct opposition to rotating air flow, in the rotating fuel and air mixture develops low-velocity eddy currents that give desired ignition. The protected burning eddies act as *a series of continuous and positive pilots* for the main body of the combustible mixture. This new tile permits *minimum load* setting of gas with rapid *maximum* settings of wind-box pressure *without loss of ignition!*

Available on new or old Peabody installations, the new Peabody Rifled Tile offers users unusually high efficiencies, plus unequalled dependability of ignition—under even the most adverse firing conditions. Write today for complete details.

PEABODY ENGINEERING CORPORATION
232 MADISON AVENUE, NEW YORK 16, N.Y.
OFFICES IN PRINCIPAL CITIES
PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

6-132

More APPOINTMENTS

Begins on page 231

Garret Rd, Upper Darby, Pa., Harry Anderson Jr, manager. **Perkin Engineering Corp:** at 1060 Broad St, Newark 2, N.J., Millard Leff, manager.

New sales engineers

Clark Bros Co: James B Hickey, Washington, D.C. office. **Edward Valves, Inc:** Clyde Sheffield, Houston office. **Warner Electric Brake & Clutch Co:** John Erbach, Milwaukee office; Clifford Petterson, Los Angeles area. **Hills-McCanna Co:** Edward H Lund, Philadelphia office; Gordon J Wagner, New York City office. **Laclede-Christy Co:** G Robert Kitzsteiner, St. Louis office.

Recent moves

Kaiser Engineers: New York executive office to 300 Park Ave and traffic and expediting offices to 620 5th Ave, New York 20, N. Y. **Air Reduction Co, Inc:** executive offices to 150 E 42nd St, New York 17, N. Y. **Farrel-Birmingham Co, Inc:** Chicago, Ill. office to 10725 S Western Ave. **Wallace & Tiernan Inc:** Dallas, Texas office to 5610 Dyer St. **The Trane Co:** Miami, Fla. office to 2009 SW 1st St., Billings, Mont. office to 403 N 24th St.

Institute elections

Air Pollution Control Association: Benjamin Linsky, president. **National District Heating Association:** Walter Gillespie, president. **Fluid Controls Institute, Inc:** John C Koch, president. **Canadian Electrical Association Inc:** Arthur C Abbott, president; Norman T Smith, vice-president. **Alloy Casting Institute:** Bradley B Evans, president; F M Fahrenwald, vice-president.

Retirements

Charles H Bay, supervisor of municipal sales, The Detroit Edison Co, after 41 years of service.

L E Lighton, vice-president and director of research, The Electric Storage Battery Co, after more than 35 years with the company.

H E Cook, chief engineer, B F Goodrich Co, after 45 years of service.

Edward J Squire, head of Dept of Civil Engineering, Polytechnic Institute of Brooklyn, after 46 years as a member of the faculty.

Frank D Carroll, Dallas district manager, The Youngstown Sheet and Tube Co, after almost 40 years of service.

Obituary

Arthur A Williams, 78, chairman of the board, Graton & Knight Co, June 9.

CHAPMAN
Tilting Disc Check Valve

There, in a nutshell, is the story of a Chapman Tilting Disc Check Valve . . . quick as a cat, quiet as a mouse. It's designed that way. It's built that way . . . for fast, sure, quiet action. Or, in other words, it's yours for best performance at lowest long-range operating costs.

With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

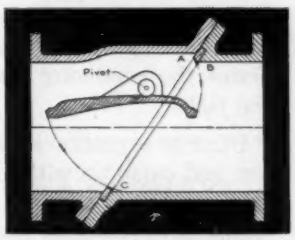
To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Disc Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

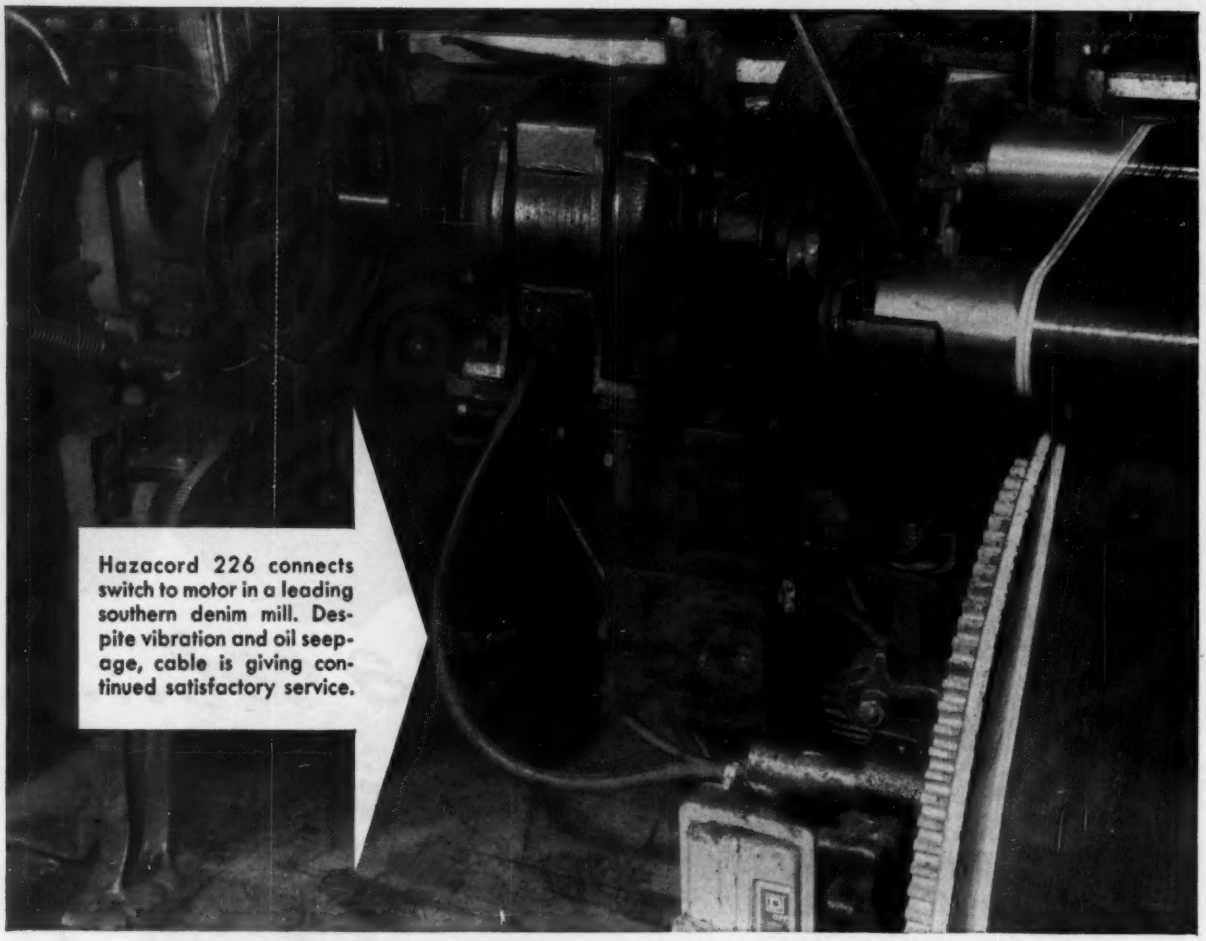
The CHAPMAN Valve Mfg. Company
INDIAN ORCHARD, MASSACHUSETTS

Never a Flutter, Never a Slam!

Designed and Built for Quiet Efficient Operation



In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.



Hazacord 226 connects switch to motor in a leading southern denim mill. Despite vibration and oil seepage, cable is giving continued satisfactory service.

new Hazacord motor lead design solves oil seepage problem

Excess oil in loom motor bearings—a common weave room problem—is a real troublemaker for motor leads. It is a *hidden* danger since the oil seeps into the cable and deteriorates the conductor insulation inside the the jacket.

Okonite engineers investigated the problem and came up with Hazacord 226. This new construction offers a conductor insulation that's just as oil-resistant as the jacket. Inside and out this cable is safe from deterioration due to oil seepage.

A year's operation on a motor intentionally over-oiled proved this oil resistance. Since then it has been proved again and again by actual mill operation in many plants.

The picture above shows an early installation of Hazacord 226 in a leading southern denim mill. Operating in typical weave room conditions, the cable is still giving satisfactory service with no signs of deterioration that causes trouble.

This is just one more example of a Hazacord construction designed to solve an unusual installation problem. For a cable designed with your problems in mind, write The Okonite Company, Passaic, New Jersey.

where there's electrical power . . . there's **OKONITE CABLE**

3550

cure summer headaches...

Prevent and cure scale, corrosion and algae odors with Perolin air conditioning water treatments

Perolin Air Conditioning Water Treatments are as simple as they are effective.

Formet Crystals will not only prevent scale formation and corrosion, they will remove deposits that have formed in previously untreated systems. And treatment is automatic—just refill with Formet Crystals once a month!

Perolin Algae Preventative #905 comes in the form of briquettes which can simply be put into the sump or pan or applied with the Formet Crystals. (Briquettes should be added daily to treat make-up water.)

These are two of the most popular Perolin Treatments—adequate for most every condition and system. But there is a Perolin Treatment for *any* special condition which might arise.

It will pay you to investigate Perolin's simple, effective, inexpensive way to keep your Air Conditioning Water Systems free of scale, corrosion and algae odors. Perolin's Field Service Engineers will analyze your system and make recommendations without cost or obligation to you. And Perolin continues to provide Engineering Assistance to its customers without charge—

This coupon will save you many a summer headache—Use it today.

Perolin SINCE 1904

The PEROLIN COMPANY, Inc.

350 Fifth Avenue, New York 1, N. Y.

PC-188

THE PEROLIN CO., INC., 350 FIFTH AVENUE, NEW YORK 1, N. Y.

Gentlemen: Please send full details, without any obligation on my part, on Perolin Air Conditioning Water Treatments.

*I use*_____*gallons of make-up water per month.*

*I have a*_____*system with a*_____*ton capacity.*
BRAND NAME

*Name*_____ *Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

IS CORROSION EATING INTO YOUR CONDENSER'S EFFICIENCY?

When condensers operate at high capacities for long periods, tube failure occurs more frequently. Corrosion is accelerated by greater loads of water—carrying abrasives and debris—traveling at high velocities. The protective film normally formed by the metal is scoured away. Water can then act directly on tube walls—eating into your condenser's efficiency!

That's why the right copper-base tube alloy for your operating conditions—the alloy that gives the *best* corrosion resistance—can reduce your corrosion rate and frequency of re-tubing.

For example: *Service data and tests conducted in clean sea water show that Aluminum-Brass, Alloy #54, gives good service where water velocities are high. Where pollution exists, the best choices are Aluminum-Brass, Alloy #54, or Aluminum-Bronze, Alloy #53.*

When replacing old condenser tubes—or specifying new ones—be sure you take full advantage of all latest developments. Bridgeport Condenser Tube Alloys are matched to your corrosion conditions for longer life, reduced maintenance. Our Technical Service and Corrosion Laboratory will be glad to help you select the *right* alloy. Phone your nearest Bridgeport Sales Office today.

Write today for your free copy of Bridgeport's new Condenser Tube Handbook. Ask to be added to the mailing list for our Copper Alloy Bulletin.

BRIDGEPORT CONDENSER TUBES

Bridgeport Brass Company, Bridgeport 2, Conn. • Offices in Principal Cities

In Canada: Noranda Copper and Brass, Limited, Montreal

Three 125,000 #/HR STEAM GENERATORS *by* Vogt AT LION OIL COMPANY'S BARTON CHEMICAL PLANT

★ The new $30 million Lion Oil Company's Barton Chemical Plant at Luling, La. produces 300 tons daily of essential nitrogen fertilizer materials to boost crop yields and reduce unit production costs on the nation's farms.

PRINCIPAL DATA, EACH UNIT

125,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 725 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

Water cooled furnace.

Burners for Gas and Oil fuel.

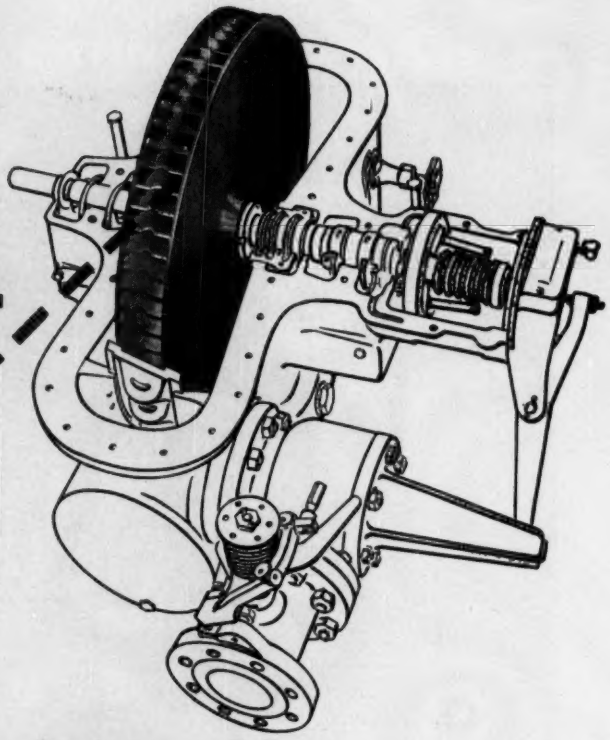
Vogt offers a complete line of custom built type and package unit type steam generators. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuel burned singly or in combination. Write for bulletins. Address Dept. 24-BP.

Henry Vogt Machine Co., Louisville, Ky.

SALES OFFICES:

New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va., San Francisco

TERRY SOLID WHEEL



..."trade mark" of a trouble-free turbine

This is the rotor of a Terry solid-wheel turbine. There are a number of reasons why it has become a symbol for reliable, trouble-free operation.

First, because the wheel is a single forging, in which a series of semi-circular buckets is milled, there are no separate parts to become loose or work out.

Second, because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets, blade wear is of little consequence. Wear does not materially affect horsepower or efficiency.

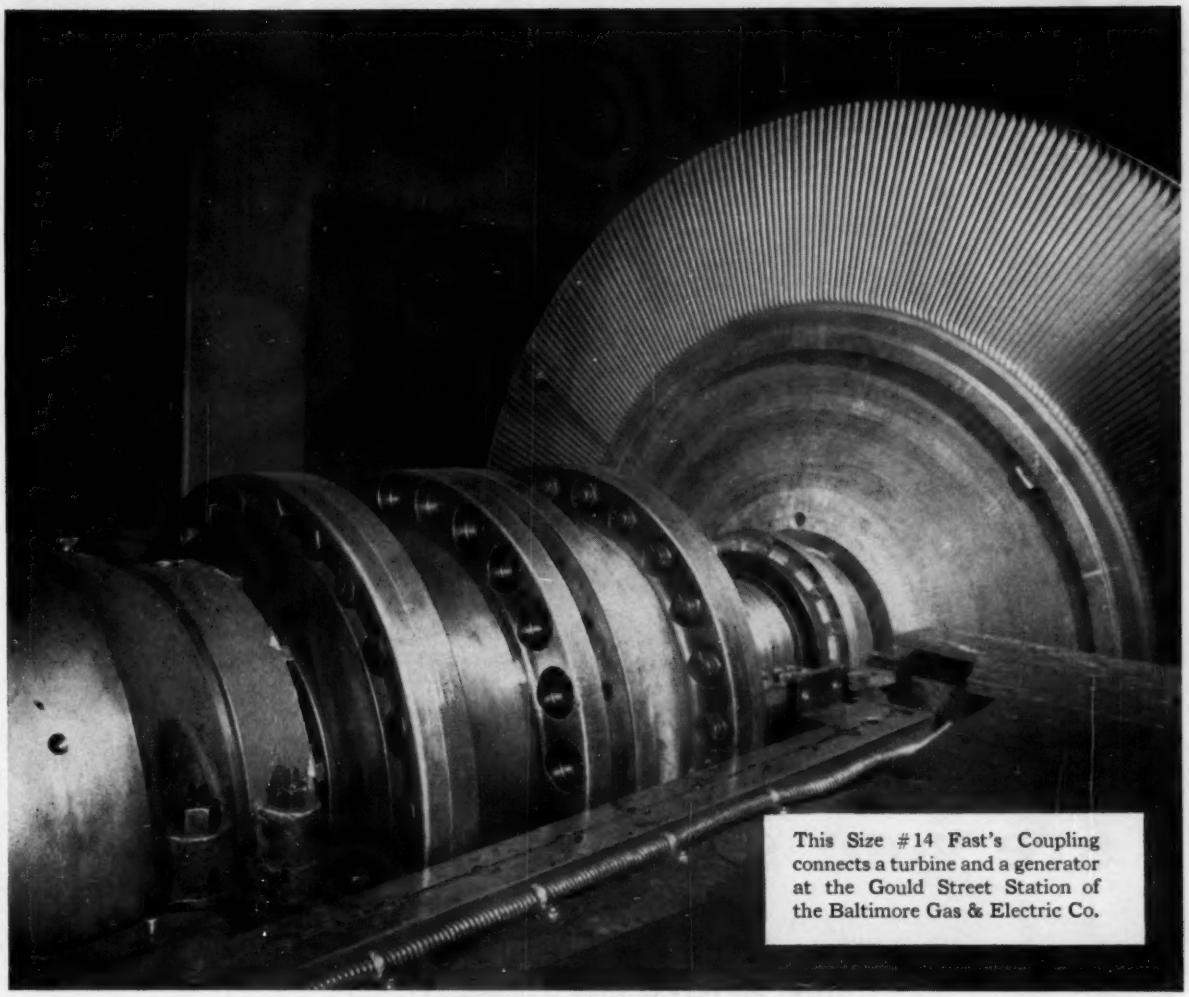
Third, because the steam enters the buckets in a direction at right angles to the shaft, there is no need for close axial blade clearances. The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, the blades are double rim protected.

These are only a few of the reasons why the Terry solid wheel has become a "Trade Mark" for trouble-free turbine performance. For complete details, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1197



This Size #14 Fast's Coupling connects a turbine and a generator at the Gould Street Station of the Baltimore Gas & Electric Co.

This Fast's Coupling runs smooth after 29 years of service!

This Size #14 Fast's Coupling has never had a major part replaced since its installation on January 4, 1927.

The Baltimore Gas & Electric Company has provided excellent care and inspection . . . examining the coupling during each routine overhaul of the turbine and generator. The last inspection (shown above) was during the fall of 1955.

Unique design permits Fast's Couplings to compensate for both offset and angular misalignment of shafts and eliminates the wear of metal upon metal. It provides positive lubrication which forms a film on load-carrying surfaces of the teeth. Metal bearing rings located at the mid-axis of the teeth keep out dirt, grit and moisture—keep lubricant in. Fast's metal-to-metal seal protects the lubricant against pollution.

A Koppers engineer can show you how Fast's Couplings will give you extra years of service and reduce down-time. For more details, write to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 3308 Scott Street, Baltimore 3, Maryland.

Koppers Company, Inc.
Metal Products Division
Baltimore 3, Maryland

***Engineered* Products**
Sold With *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

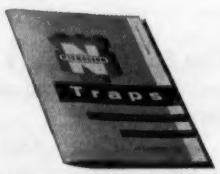
are your steam traps ready...

for peak demand in the winter months?

Don't risk the possibility of equipment failure ... even freezeups. Check your steam traps right now, before the first frost.
Drain them, take them apart, make sure that all parts are working and free from corrosion.

Of course, if you already use Nicholson steam traps, you're in luck. They completely drain themselves when cold. And with just three parts, they're the simplest traps to look after when a checkup is in order.

But regardless of what traps you use at the present time, we'll be glad to help you with any problem you may run into in getting your equipment in shape.



Write, today, for your copy of new Bulletin 10-55—for detailed information.

NICHOLSON

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TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY
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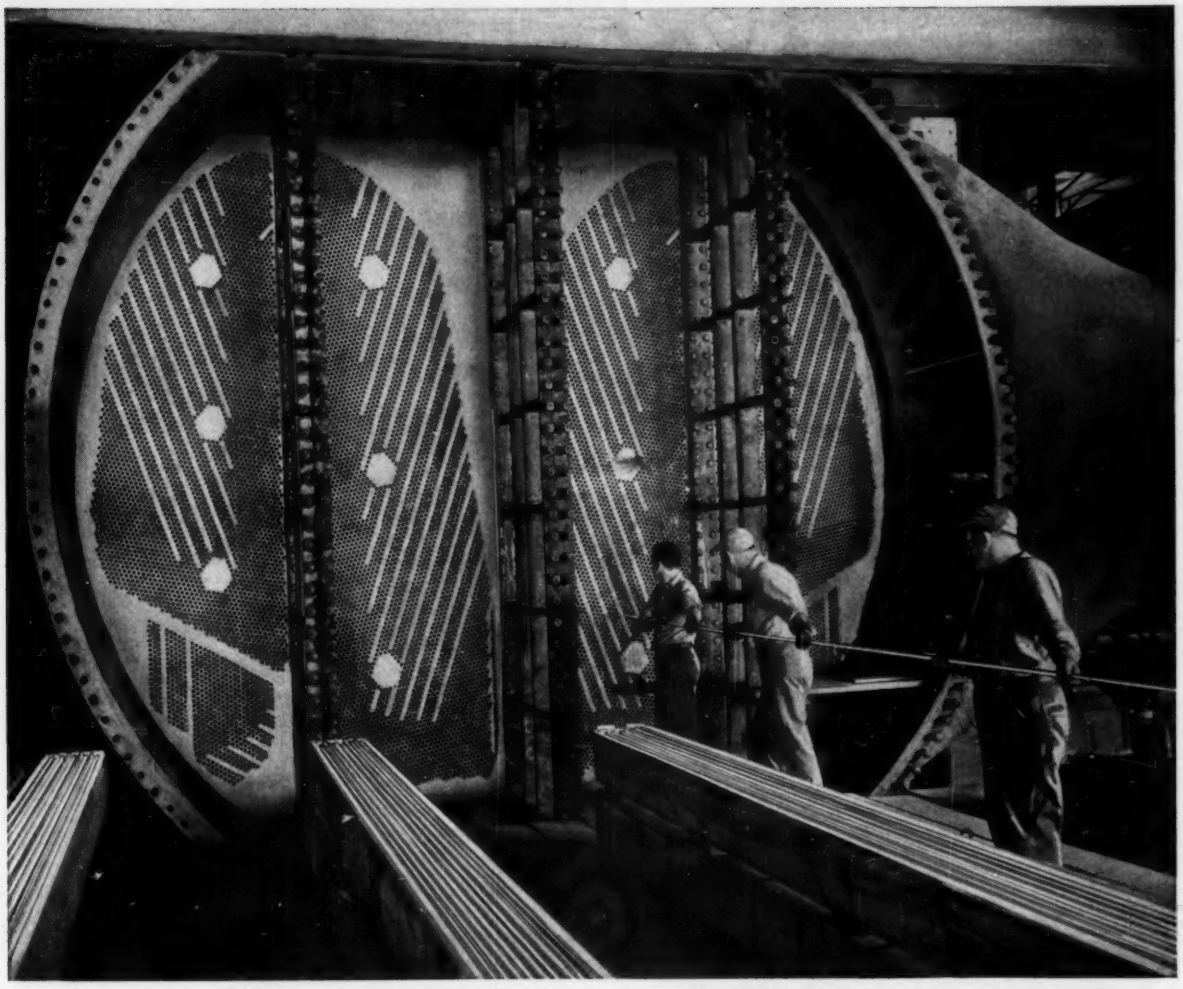

IN FOR A BIG HEAT-TRANSFER JOB

...AND MANY YEARS OF SERVICE FROM

CHASE® ANTIMONIAL ADMIRALTY TUBE!

Remove 988 Btu's per pound of steam! Condense 1,046,830 pounds of steam per hour! Cool with raw lake water! That's the job of a single-pass condenser for a Great Lakes power and light company.

And Chase Antimonial Admiralty was selected for the condenser tubes in this installation with many years of trouble-free service anticipated. You see, Chase Antimonial Admiralty condenser tubes have *virtually eliminated* tube failures caused by dezincification. Perfect alloying and tempering provide freedom from season cracking and permit easy rolling into tube sheets. And rigid quality controls at the mill assure tube as flawless as science can make it.

Make sure your new and replacement condenser tube installations will *really* give long service. Insist on Chase Antimonial Admiralty!

Chase®

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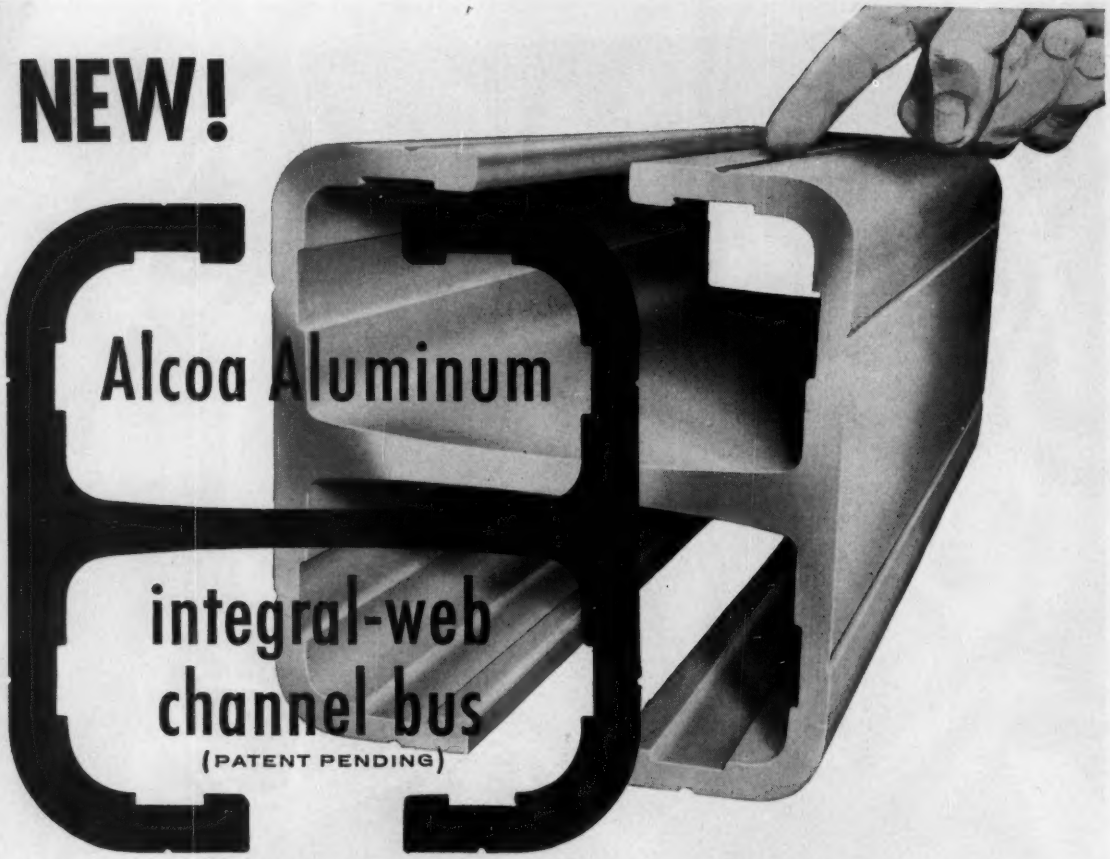
NEW!



Major new development in bus conductor offers maximum protection against short-circuit forces in high-current systems.

Strong as a girder, easy to install, high in current-carrying capacity, Alcoa® Aluminum Integral-Web Channel Bus Conductor offers pronounced advantages over other types of conductor for such applications as generator leads, substation bus and industrial plant use.

Its integral-web construction eliminates need for spacer clamps or welded bars across channels. The special extruded shape gives a large surface area to accommodate high current in either ac or dc circuits. Its high section modulus provides the mechanical stiffness needed to resist the forces of short circuits without damage or distortion.

Joints, taps and splices can be clamped, bolted or welded. Special grooves mark exact center lines for drilling bolt holes so that nuts lock in recesses designed to eliminate back-up wrench. Channels, plus vent holes in center web, provide high degree of ventilation, cooling and drainage.

For complete information, contact your Alcoa repesentative or write Aluminum Company of America, 2312-H Alcoa Building, Pittsburgh 19, Pa.

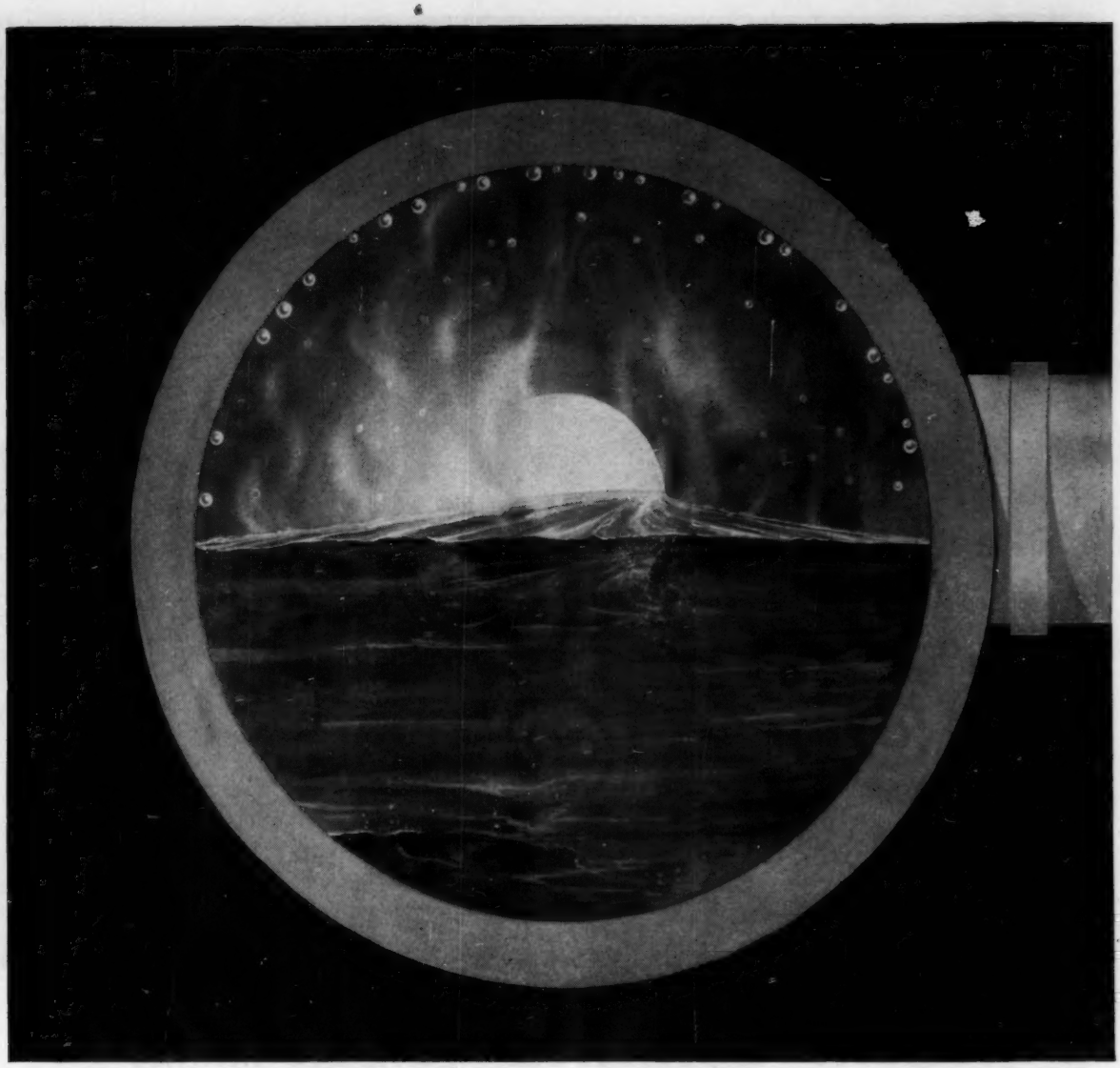
SIZES	NOMINAL CURRENT* (amperes)
4 x 6	3,500
5 x 6	4,000
8 x 8	7,000
11 x 11	10,000
12 x 12	12,000

*(based on 30° C rise above 40° C ambient still air)

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

ALCOA ALUMINUM
ELECTRICAL CONDUCTOR
ALUMINUM COMPANY OF AMERICA

Your Guide to the Best in Aluminum Value



WHAT'S A MONOMOLECULAR FILM?

It is a film one molecule thick. Filmeen* in steam or condensate lines produces a monomolecular film.

But, there's a lot more to it than thickness. The film's most important function is protection against corrosion. By forming a nonwettable coating on all metal surfaces with which treated steam or condensate come in contact, Filmeen provides a protective, corrosion-inhibiting barrier between water and metal. In heat exchange equipment, the condensed steam treated with Filmeen then forms as spherical drops of water which resist adherence to the film surface, much the same as a drop of water will form into a small ball on a waxed surface. This phenomenon results in increased rate of heat transfer—which in turn saves money in power plant operation.

When steam condenses on untreated return lines, it forms a continuous layer of water that restricts heat transfer. You don't want that... it raises the cost of heat.

Your Dearborn sales engineer will gladly explain how Filmeen can keep your heating costs in line.

**Filmeen is the trade-mark of a corrosion-inhibiting compound produced exclusively by Dearborn Chemical Co. U.S. Pat. No. RE 23614.*

Dearborn®

a leader in water conditioning and corrosion control

Dearborn Chemical Company
Dept. PO, Merchandise Mart Plaza, Chicago 54, Ill.

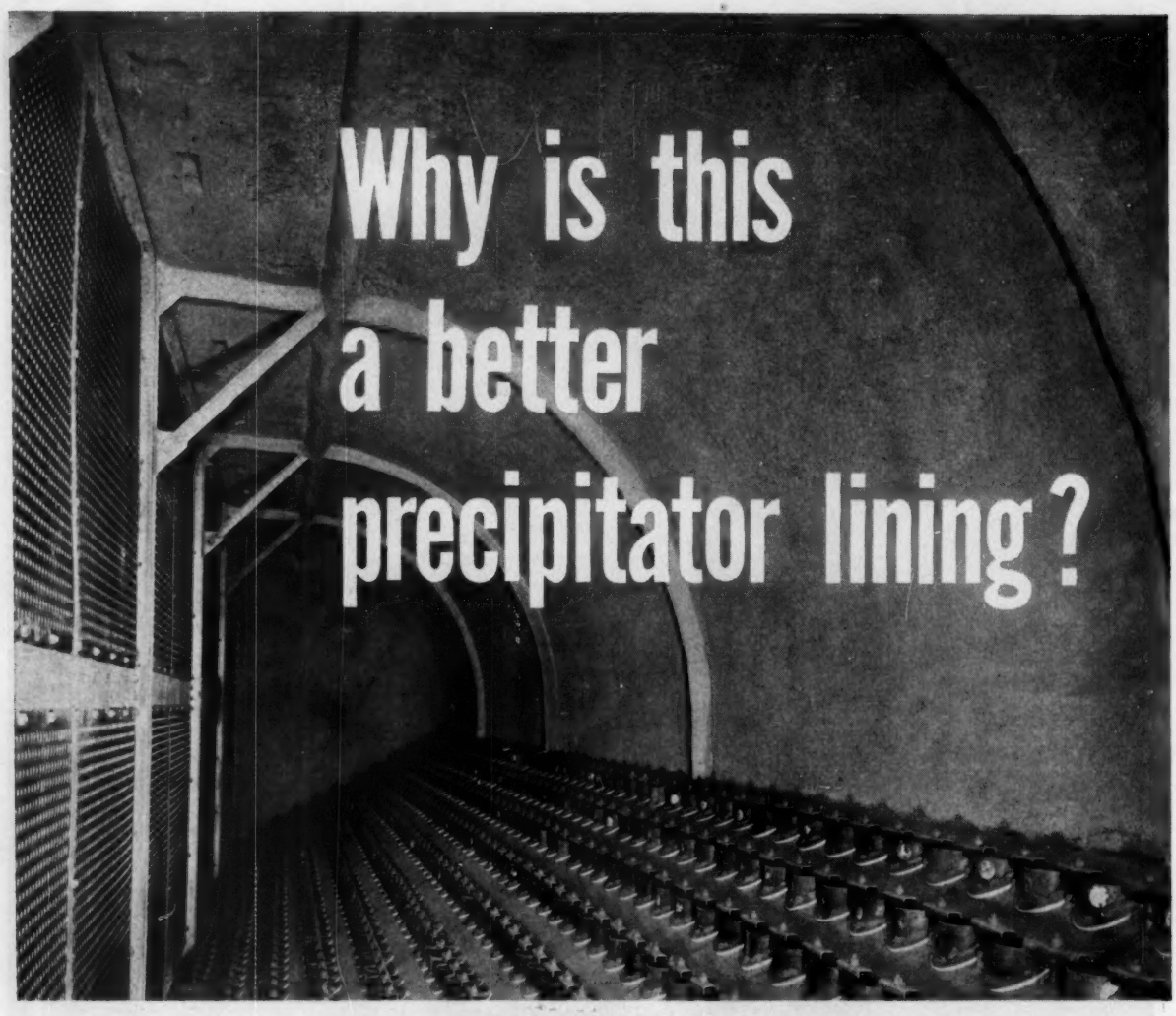
Please send me complete information about Filmeen.

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....



because **LUMNITE*** - concrete linings give trouble-free service, year after year

Where temperature and abrasion can cause excessive wear — as in above multiclone ash precipitator — plant operators are using Lumnite-concrete linings. Once installed, Lumnite industrial concretes give rugged resistance against heat, corrosion, abrasion and thermal shock, while reducing repairs and downtime to a minimum.

You'll find, too, that concretes made with Lumnite calcium-aluminate cement are easy to place, and *stay* in place, whether they are poured, troweled, or gunited. And, for maximum convenience, you can use a Lumnite-base castable. Because these are pre-mixed and ready to use, castables give uniform performance and are especially handy in emergencies. Lumnite-base castables are made and distributed by leading manufacturers of refractories. For more information, write:

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

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*"LUMNITE" is the registered trademark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.

L-129

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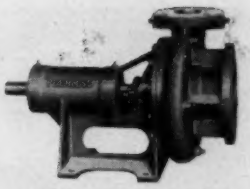
How to Save

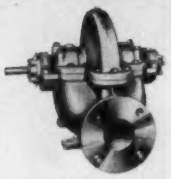
TIME \ MONEY \ ENERGY

TYPE PE FLUIDYNE INTEGRAL HP PUMPS
A complete line of electric close-coupled general purpose pumps. Threaded or flanged connections. Capacities: to 800 gpm; heads: up to 260 feet; motors: up to 50 h.p.



TYPE PB FLUIDYNE GENERAL PURPOSE PUMPS
Flexible coupled, single-stage, end suction, general purpose pumps. Rugged and durable. Capacities: up to 5500 gpm; heads: up to 260 feet; motor: up to 150 h.p.

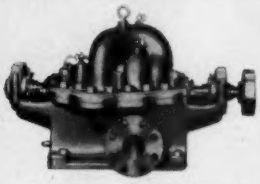
TYPE A GENERAL PURPOSE PUMPS
For application to the widest variety of pumping conditions. Single stage split case design. Capacities: up to 70,000 gpm; heads: to 300 feet. All types of drive.



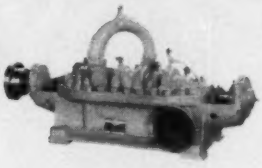
TYPE AS GENERAL PURPOSE PUMP
The centrifugal pump with mechanical shaft seals that eliminate the packing box. Up to 4" in discharge sizes. Capacities: up to 750 gpm; heads: up to 210 feet.

BY BUYING FROM THE COMPLETE LINE

VERTICAL DEEP WELL TURBINE PUMPS
For application to deep well pumping. Lifts from 1000 feet or more. Capacities: up to 30,000 gpm. H.P. range: up to 1000 h.p. oil and water lubricated types. Widest range of sizes.



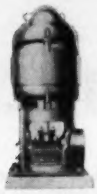
TYPE TU BOILER FEED AND PROCESS PUMP
2-stage high pressure pump for water and other liquids. Capacity: 50 to 3500 gpm; heads: up to 600 feet. Internal cross over is built into top half of pump case.



TYPE TUT MULTI-STAGE PUMPS
3, 4 and 5-stage pumps for water handling and process services. 1" to 5" discharge sizes. Capacity: up to 1350 gpm; head range: up to 1600 feet. Split case design.

INDUSTRIAL SERVICE PUMPS
For application to pits, sumps, basins, reservoirs and other surface water sources. Same capacity as deep well turbine above. H.P. range: up to 2500 h.p.

HYDRO-LINE PUMPS
An enclosed, close-coupled, vertical centrifugal process pump for handling petroleum hydrocarbons, where NPSH is limited. Capacities: to 6000 gpm; heads: to 1500 feet.



HI-LIFT PUMPS
The unique positive displacement deep well pump that literally squeezes water upward. Capacity: 10 to 55 gpm; lifts: up to 1000 feet. For wells 4" in diam. and up.

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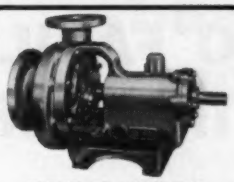
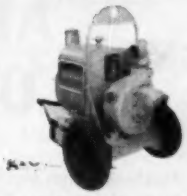


TYPES DL AND DM PROCESS PUMPS
Single stage, end-suction chemical process pumps with maximum interchangeability of components. Open or enclosed impellers. Packing gland or mechanical seal. Capacities to 800 gpm. Heads to 430 feet. Temperatures: to 450° F.



SELF-PRIMING PUMPS
Rugged, compact, portabe self-priming pumps manufactured to AGC specifications, seven models and types to choose from providing 4,000 to 30,000 gallons per hour.

FOR ALL YOUR PUMPS FOR ALL YOUR NEEDS—LOOK TO PEERLESS FOR:

THE COMPLETE LINE—
THE QUALITY LINE—
THE DEPENDABLE LINE—
THE ECONOMICAL LINE—
THE TIME-SAVING LINE!

PEERLESS PUMP

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

PEERLESS PUMP DIVISION
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Offices: New York; Indianapolis; Chicago; St. Louis; Plainview and Lubbock, Texas; Fresno, Atlanta; San Francisco, Los Angeles; Phoenix; Albuquerque.

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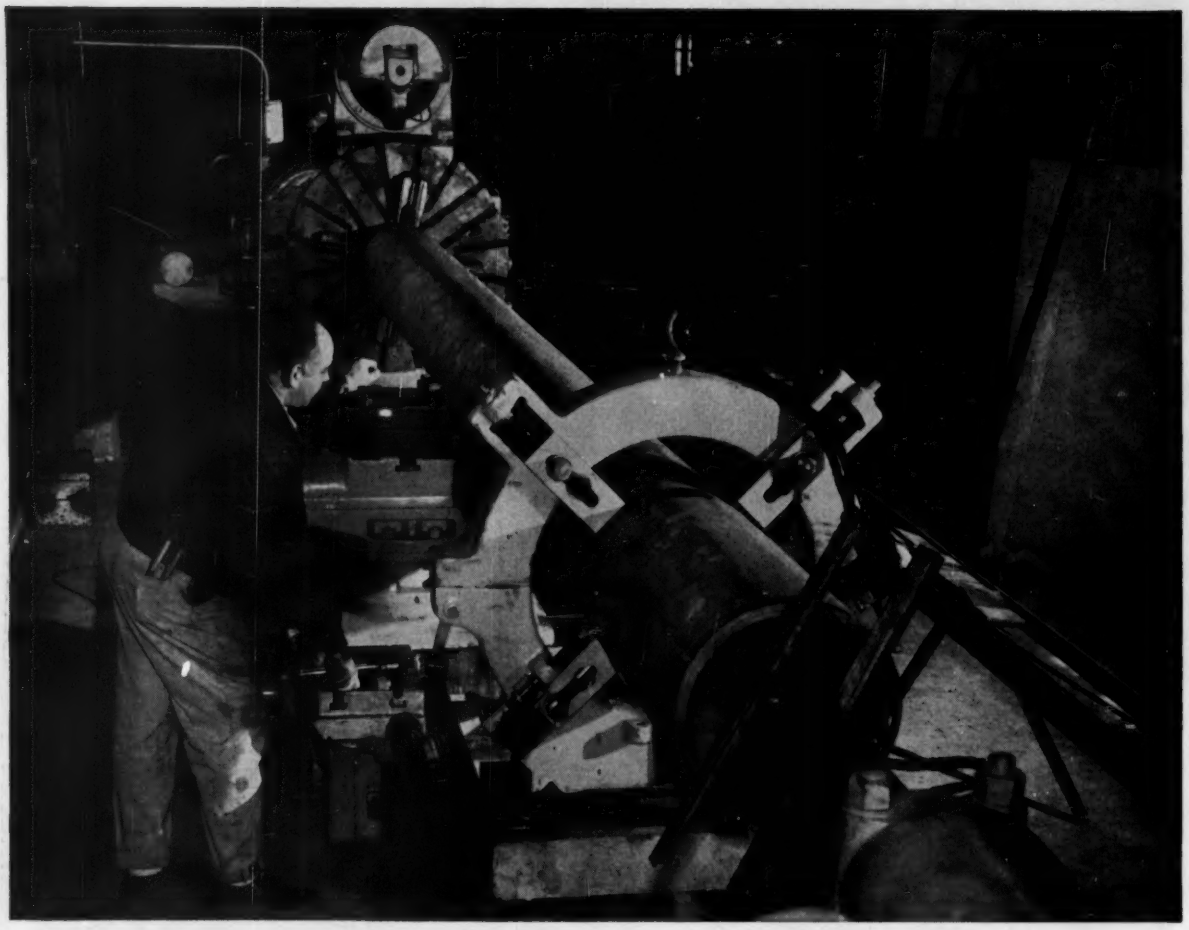

ALCO FACILITIES ASSURE VALUE IN PREFABRICATED PIPE

Machines and Methods at ALCO's Plant Handle All Sizes of Seamless Pipe, Any Alloy or Grade; Modern Welding Techniques Used for All Materials.

ALCO brings to prefabricated pipe production a modern plant, completely equipped with machine tools to handle any size, alloy or technique. Facilities include large lathes *(above)*, other heavy machine tools, induction heat-treating for joint preheat and stress relief after welding.

Advanced quality control methods are another important factor in ALCO prefabricated pipe. Use of X-ray machines and cobalt 60 pills to test welds is an example of up-to-date inspection and test procedures.

Experience and production know-how are also factors in ALCO prefabricated pipe. Pipe manufacture draws on welding techniques which have placed ALCO in a leading position in the welding field. ALCO's experience in heat-exchange equipment, both refinery and power plant, aids in piping manufacture.

Your inquiries on ALCO piping will receive prompt handling at any ALCO Sales Office, or, if you wish, write P. O. Box 1065, Schenectady 1, N. Y.

Information on how to obtain the ALCO piping drawing layout template, a definite aid in making piping layouts, is available from ALCO, P. O. Box 1065, Schenectady 1, N. Y.

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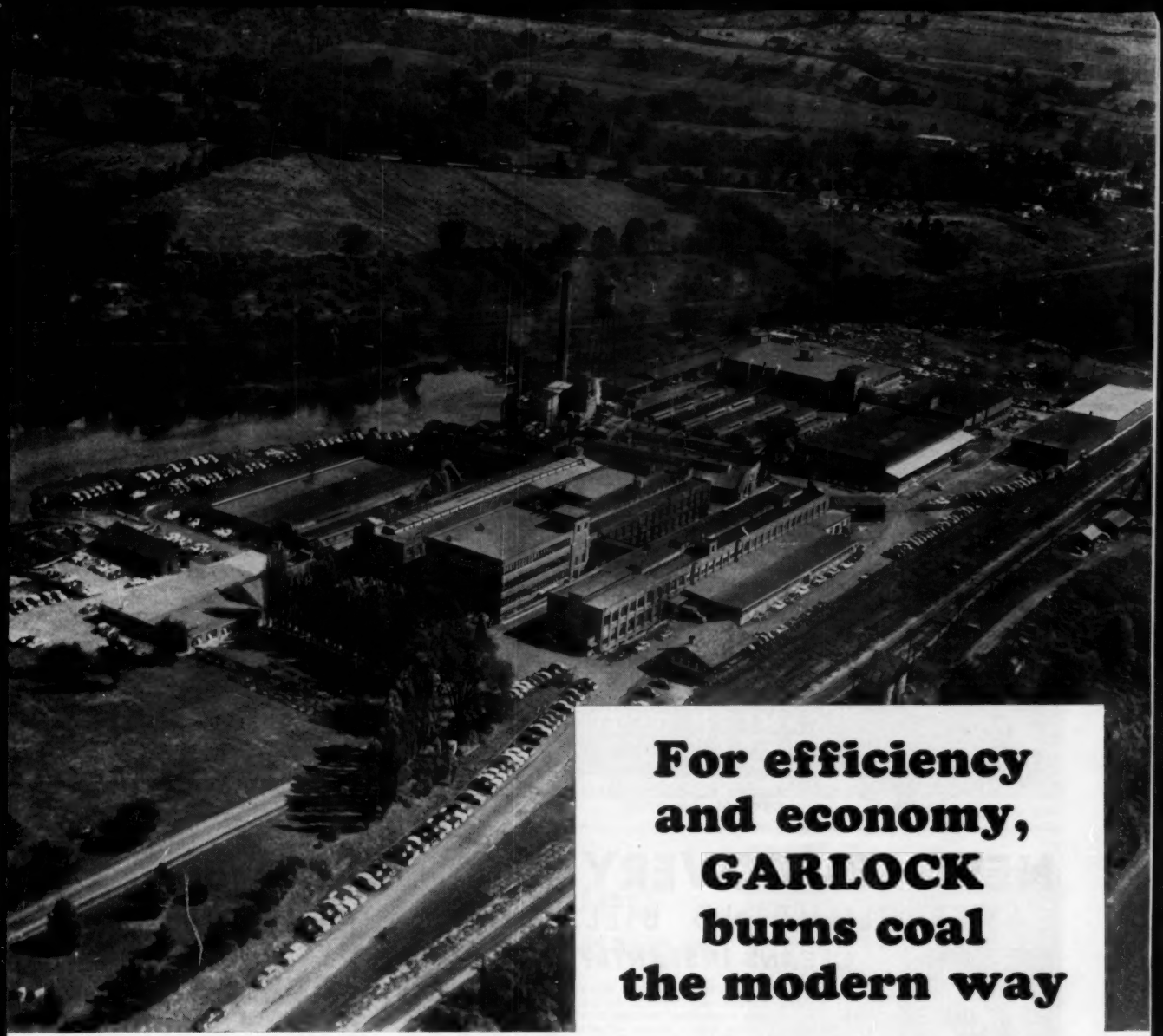


For efficiency and economy, GARLOCK burns coal the modern way

The Garlock Packing Co., Palmyra, N.Y., had a problem common to many growing firms. Production requirements threatened to outpace its power system. Steam capacity and electrical distribution were inadequate; heat balance was poor; equipment was obsolete. Any minor repair or inspection meant curtailed production. So Garlock called in Consultant L. J. Sforzini to study the situation and make recommendations.

The answer was *modernization* and today Garlock burns coal the modern way. A new 100,000 lb.-per-hr. spreader-stoker fired boiler, using older units as standbys, delivers steam for all needs with enough surplus capacity to handle a load growth. Cinder reinjection has improved stoker-firing efficiency. Pneumatic ash handling facilitates overall operation. With these and other changes, Garlock's power plant now operates at peak efficiency and economy.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building • Washington 5, D. C.

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use • No smoke or dust problems when coal is burned with modern equipment • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

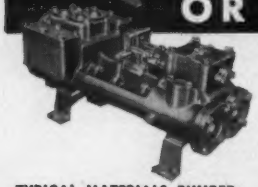
HANDLING BULK MATERIALS ?

take it up a Flo-Tube,

the spiral conveyor of dependable service. Used on incline or horizontally.

Mechanically handles materials from grain size to lump . . . sand, rice, seed, pellets, flakes, steel chips, wood waste, coal, etc.

OR LIQUIDS ?



WAGENER PUMPS

SIMPLEX DUPLEX

STEAM or POWER models for any need

TYPICAL MATERIALS PUMPED:
ACIDS, ALCOHOLS, BEER & POTATO MASH, DYES, GLUE, OIL (any kind), ASPHALT, BRINE, MILK, MOLASSES, SOAP, SEWAGE, WATER, TAR, GROUT

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***Specialists in* Automatic Coal FIRING, HANDLING and CONTROL Equipment and CANTON INCINERATORS**

CANTON STOKER CORP.

CANTON STOKERS

741 ANDREW PL., CANTON, OHIO
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NEW! DISCOVERY!

SAVES PLUMBING BILLS

CLEANS INSTANTLY

CHICAGO—August 5th—Factories, Machine Shops, Offices, Institutions, Schools, including Home Owners are constantly having trouble with clogged-up pipes which proves expensive in Costly Plumbing Bills—

But now — using Water Impact and Air Pressure, here is a new unit called the **Plumber's Flushing Gun,** which cleans all lines up to 100 ft. It will open any number of bends in pipe. Yet anyone can operate this new gun, which triggers easily.

TOILETS, URINALS, SINKS, and FLOOR DRAINS clogged with paper, grease, rags, sand, and other debris can be cleared with one or more shots from the gun, **saving the owner, the Gun's price the first time it is used.** This new Flushing Gun may be used on any ½ to 6 inch waste pipe including Sink Drains, Floor Drains, Hot Water Pipes, Drinking Fountains, Septic Tanks, and Urinals. Obstructions melt away INSTANTLY when struck by the hammer like blow of this new unit.

This new Plumber's Flushing Gun is offered on a 30 Day Free Trial to prove its value. **BUT MOST IMPORTANT IS THIS**—What is this Tool worth to your Factory, Building, Machine Shop or in your own Home in **Costly Plumbing Bills Saved.** For your own good—Fill coupon right now—No agent will call—Obey that urge, mail now or write postcard. (Chicago Phone Kildare 5-1702)

MILLER SEWER EQUIPMENT, INC.
Dept. Power, 4638 N. Central Ave., Chicago 30, Ill.

Please send FREE BOOKLET on Flushing Gun, I am not obligated.

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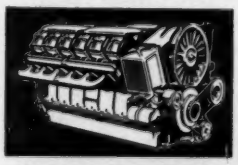
DEUTZ
DIESEL

began in 1948 to build air-cooled DEUTZ diesel engines in large series. 7 years after, in 1955, the oldest engine manufacturers in the world had built and sold 150.000 air-cooled DEUTZ diesel engines totalling 7.5 Million B.H.P. These equipment engines are used all over the world for every kind of application. DEUTZ builds air-cooled 1 to 12-cylinder diesel engines with an output range from 5 to 250 B.H.P. for road vehicles, rail vehicles water craft, working machines in all fields of application, generator sets for stationary and mobile electric and power plants.



air-cooled

KLÖCKNER-HUMBOLDT-DEUTZ AG. KÖLN

Address inquiries from U.S.A., Alaska, Hawaii and Puerto Rico to:

DIESEL ENERGY CORPORATION
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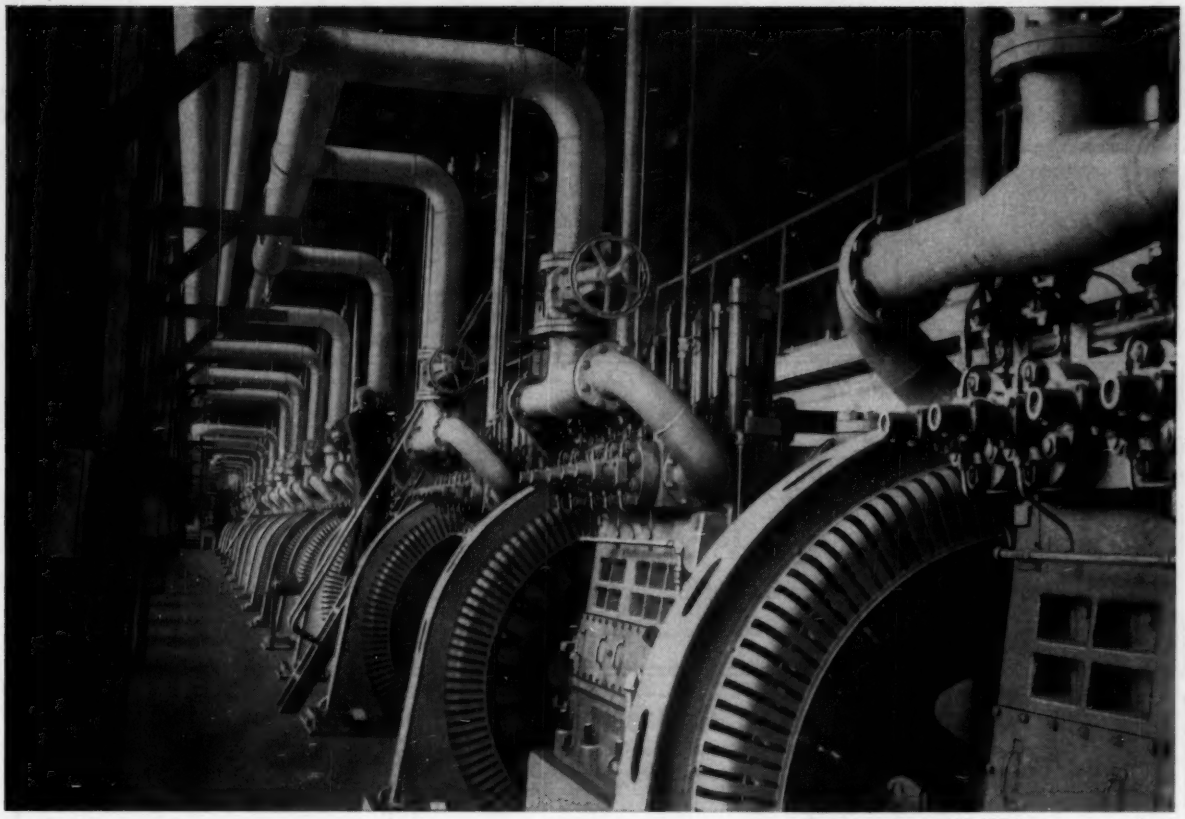


It takes a total of 12,600 hp to operate these 24 pumps that supply the 2500 psi water for press operations.

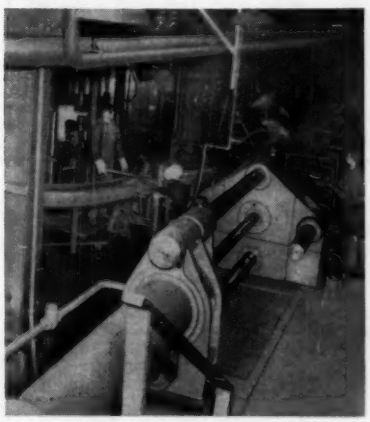
This Hydraulic Piping speeds shell production

Water at 2500 pounds pressure surging through this piping system helps squeeze out 155 millimeter and 8 inch shells. This is how production is activated at the new government-owned Scranton Ordnance Plant, operated by United States Hoffman Machinery Corporation, Scranton, Pennsylvania.

The high pressure water supply that operates the hydraulic shell forming presses comes from this battery of twenty-four pumps. When using the presses, water surges through the system in jolts to meet the press demands. Such rugged service requires foolproof piping fabrication as a failure could be disastrous.

To guard against any possible failures from these extreme pressure variations, the piping system was thoroughly inspected and tested, at pressures well above what might be encountered. Fabrication was done in Dravo's Marietta, Ohio, piping plant with erection being completed under the close supervision of Dravo field fabrication specialists, so that uninterrupted performance is assured under the severest of service.

You, too, can profit through Dravo's single-contract responsibility, ranging over all types of jobs from power or boiler plant construction to the fabrication and erection of piping systems. Write for complete information.



View of actual press operations in the forming of 8" shells. Large diameter pipe feed lines were anchored every 10 ft. to guard against shaking loose.

Dravo Corporation, Department C-2112
Fifth & Liberty Avenues
Pittsburgh 22, Pa.

I am interested in Dravo Construction Services for _____

☐ Please send Bulletin #1200

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CORPORATION
Pittsburgh 22, Pennsylvania

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Widest Range of Sizes & Specs in the U.S.
WRITE FOR STOCK LIST
MIDCONTINENT TUBE SERVICE, INC.
2308 Oakton St., Evanston, Ill. DA 8-4030

This
WHERE TO BUY
Section

supplements other advertising in this issue with these additional announcements of products and services essential to modern plant management and Maintenance. Make a habit of checking this page, each issue.

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P-2291, POWER
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MArket 7-1963

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D.C. MOTORS WITH M.G. SETS & CONTROLS

Qu.		MAKE	TYPE	VOLTS	R.P.M.
1—	2200 HP	G.E.	MCF-12	600	400/500
	22001KW	G.E.	Syn.	2300/4600	514
1—	1250 HP	G.E.	MCF	600	600/750
	1000 KW	G.E.	Syn.	2300/4600	720
1—	1000 HP	G.E.	MCF-8	600	350/700
	1000 KW	G.E.	Syn.	2300/4160	720
1—	200 HP	G.E.	CD-1650Z	250	500/1500
	200 KW	Whse.	Syn.	440	1200

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G.E.	MT	6600	257
1	1500	G.E.	MT	6900	1187
1	1100	G.E.	IM	2300	720
1	1000	A.C.	Mill	2300	240
1	800	G.E.	MT	2300	293
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D.P.	2300	500
1	500	Whse.	CW	550	350
1	400	Whse.	CW-960A	440	1176
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G.E.	IM-17A	440/2200	720
1	250	G.E.	MT-424Y	4000	257
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
1	150	Whse.	CW30E17	2300	435
2	125	A.C.	ANY	440	865

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
2	650	G.E.	FT-559BY	440	3570
2	450	Whse.	CS-1420	2300/4150	354
1	400	G.E.	1E-15B	2300	1165
1	400	G.E.	1K	2200	500
1	300	G.E.	1K-17	440	580
3	200	G.E.	KT-557	440	1800
1	150	Whse.	CS	440	580

SYNCHRONOUS

1	7000	GE	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
3	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900
2	2000	Whse.		2300	120
1	1100	G.E.	ATI	2300/4600	900
2	500	G.E.	TS-7567	2200	1200
1	450	Whse.		2200	450

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
1	3000(3U)	G.E.	514	600	4000/6600/13200
2	2000/2400	G.E.	450	250/300	2300/4600
1	2000	G.E.	500-25cg	660	11000
2	2000	G.E.	514	600	4600/2300
1	1750/2100	G.E.	514	250/300	4800/2400
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	514	250	2300/4600
1	1250	Whse.	720	600	2300
1	1000	G.E.	900	260	6600
1	750	Whse.	900	250	2300/4150
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
1	150	Whse.	1200	600	2300
1	150	Whse.	1200	275	2300

WELDING M.G. SET

Gen. Elec.—1100 Kva—0.7 p.f.—2300/4600 V. 3/60 Generator with 1750 Kva—.8 p.f.—2300 V. 3/60 motor complete with exciter set and controls.

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	3000	A.C.	OISC	3	33000x2400/4160
1	2500	Al.Ch.	OISC	3	34500x13800
1	2500	Al.Ch.	Fur.	3	13800x14f/11B
3	500	Kuhl	OISC	1	13800x6900
3	333	G.E.	HS	1	7200x2400x4160Y
3	333	G.E.	HSWB	1	2300/4000x230/460
3	333	G.E.	RD	1	13200x2530x4350Y
3	200	Whse.	OISC	1	13200x120/240

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	5000	G.E.	60/50/60	6600/11000/6600
2	2500	G.E.	25/62.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	500	Al. Ch.	25/60	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 P.T.T. Surface Condenser 3/60/2300/4000 V Direct con exciter.
1	1500	Whse.	Auto extraction 190 lbs. — 660° P.T.T. 60 lb. extraction 3/60/240 V. Div. conn. Exc.
1	1000	Moore	Auto-Ext. Cond 175/200# U.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300. Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P., 430/3/60.

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43 Howell St., Jersey City 6, N. J.

FOR SALE
A.C. & D.C. DIESEL GENERATOR SETS

A.C. SETS

(3) 200 KW G.M. model 8-268A—8 cyl.—air starting—6½ x 7—heat exchanger cooled—driving Westinghouse generator—200 KW 440/3/60—1200 RPM—with direct connected exciter and complete with panel board for generator, engine starting air compressor and starting air tanks. Reconditioned by U.S. Navy. Units in excellent condition. Price on request.

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30 KW—120 volt DC—Sheppard model 12—6 cyl.—4 x 6—50 HP at 1200 RPM—continuous full load rating—radiator cooled—built to ABS & AIEE #45—class A insulation—electric starting. GENERATOR: 30 KW—120 volts DC—250 amps—shunt wound—40° rise.

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sizes 25 KVA to 250 KVA
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In Units of 1500-KW., and 3000-KW., Each.
13,800 Volts A.C.: 600-Volts D.C.
Complete with breakers and All Control Equipment.

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TRANSFORMERS

3—15,000 KVA—132,000Y—13,800 volts
3— 8,333 KVA—66,000/38,000/11,900/6800 volts
3— 667 KVA—6900/13,800—2300 volts

HEATER

1—120,000# Deaerating Heater—Tray Type

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100 KW to 1500 KW
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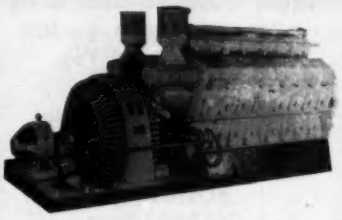

(1) ONLY 1250 KVA 4600/2300 VOLT 3 PHASE 60 CYCLE 720 RPM WESTINGHOUSE SYNC. A.C. GENERATOR—80% PF—S.O. 6P455 WITH DIRECT CONNECTED 10 KW EXCITER—ENGINE MODEL 16-567 ELECTRO-MOTIVE DIV. G.M.

Inspection In Detroit

Just purchased from General Motors, Detroit, Diesel Engine Division, where it was used as stand-by generator only! No expense was spared to keep it in "like-new" condition. At specific periods, without regard to wear, parts such as pistons, liners, rings, etc. were replaced. And the unit has been insured to the strict standards of the Hartford Insurance Co. Generator was used on afternoon shift only and was never run around-the-clock. Spare parts included (1) factory reconditioned blower (1) extra blower; and a quantity of new pistons, liners, heads, bearings, etc. Unit complete with Westinghouse oil circuit breaker—15000 volts—type F-124—600 amps.—60 cycle—solenoid operated—mounted in drawer-type cubicle 20" wide—44¼" deep—88" high. Motor operated rheostats.

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Also Located Same Plant

(1) 12-567 1000 HP diesel engine made by GM Electro-Motive Div.—driving 850 KW 550 volt DC generator at 720 RPM. if you need DC, here it is! Same outstanding condition as 1250 KVA unit detailed above.

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EVERY MACHINE COVERED BY THE WAGNER GUARANTEE

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
200	Reliance	1400-T	230	850
175	Cr. Wh.	151-H	230	800
150	Whse.	SK-184	230	850
100	Reliance	651-T	550	1000/1600
100	Reliance	651-T	230	575/1150
75	F. Morse b.b.	DH-140	115	1600
65	Cr. Wh.	CMC	230	575/1100
60	Allis Ch.	E-146	230	1150
50	G.E. (3)	CD-125	230	400/1200
50	G.E. b.b.	CD-93		3500
40	Reliance b.b.	131-T	550	1750
30	Imperial b.b.	D-69	230	400/1600

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V.
300	Gen. Elec.	2200/440 AC	260 DC
200	G.E. converter	220/440 AC	250 DC
200	El. Machy.*	2200/440 AC	250 DC
200	Whse.*	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.*	220/440 AC	250 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	G.E.*	2200/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	Cr. Wheeler	25 cycle	125 DC
75	Whse.	2200/440 AC	600 DC
60	Whse.	220/440 AC	250 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
35	Whse.	220/440 AC	250 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	G.E. (2)	CY-275	260	1200
200	Reliance	1400-T	250	1200
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	850
100	Whse.	SK-180	250	900
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Whse. b.b.	SK-163	125	1000
60	Allis Ch. (3)	E-146	250	1500
50	Gen. Elec.	CD-115	250	1200

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	Allis Ch.	Sq. Cage	440	900
600	G.E.	Slipring	2300	600
500	G.E.	Sq. Cage	2200	3600
500	Whse.	Slipring	2200	450
500	G.E.	Sq. Cage	4000	1800
450	Allis Ch.	Synch.	480	400
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
350	G.E.	Sq. Cage	2200	1800
300	G.E.	Slipring	2200/440	600
300	G.E.	Sq. Cage	440	900
300	Whse.	Synch.	440	1200
300	Gen. Elec.	Slipring	220/440	1200
300	G.E.	Slipring	440	450
250	G.E.	Slipring	440	1800
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Gen. Elec.	Synch.	220/440	450
250	G.E.	Synch.	220/440	720
250	L.A. (2)	Sq. Cage	220	1800
225	G.E.	Synch.	220/440	900
200	G.E. b.b.	Slipring	2300/440	720
200	Whse. (2)	Slipring	2200	514
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	220/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	E.M.	Synch.	220/440	1200
175	G.E. (2)	Synch.	220/440	720
150	El. Machy.	Synch.	220/440	360
150	G.E.	Slipring	2200/440	720
150	G.E. (4)	Slipring	2200/440	600
150	G.E. (2)	Sq. Cage	2200/440	720
125	Whse. TEFC	Sq. Cage	2200/440	720
125	Gen. Elec.	Slipring	440	600
125	G.E. TEFC	Sq. Cage	220/440	3600
125	Ideal	Slipring	4000/2200	900
100	Whse (2)	Sq. Cage	2200	900
125	G.E.	Slipring	220/440	450

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1—2200 CFM, I.R. COMPRESSOR Type XPV, 110 PSI

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2—300 HP KEWANEE, 125 PSI.

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TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	750	G.E.	H	1	4600-120/240
1	750	G.E.	HT	3	4150Y.220/440
2	250	G.E.	H Pyranol	1	2400-4800/8320Y-120/240
2	250	West.	Inerteen	1	2300/4600-230/460
3	200	G.E.	H-KD	1	13800/12420/4600-240/480
3	200	G.E.	H	1	7800/15600-220/440
1	150	Eisler	OA	3	4160-240/480
3	50	Penn	OISC	1	2400/4160Y-240/480
3	50	G.E.	H	1	2400/4800-120/240
1	25	G.E.	H Pyranol	1	2400/4160Y-120/240
6	15	Maloney	KL	1	2400/4160Y-120/240

SYNCHRONOUS MOTORS

Qu	HP	Make	Speed	Type	Volts
1	100	G.E.	900	TS	2300
1	125	G.E.	600	TS	2300
1	125	E.M.	900		4800
1	150	G.E.	1800	TS	220/440
2	150	Allis-Ch.	360		2200
1	150	West.	900		220
3	200/100	West.	720/360	SYN	4150
1	300	E.M.	720	TEFC	2300
1	500	West.	450	HR	440
1	1000	West.	360	Mill	2300/4150

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
1	15	G.E.	900	MT-542	440
1	25	G.E.	900	MT-526	440
1	60	G.E.	1800	MT	220
1	60	Ideal	900	AV	220
1	75	G.E.	600	IM	440
1	150	West.	900	CW	2300
3	150	Allis-Ch.	1800	AY RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	1200	M	2400/4150

SQUIRREL CAGE

Qu	HP	Make	Speed	Type	Volts
1	75	Ideal	1200	AT-505	220/440
1	75	G.E.	1800	K-445S	440
1	100	West.	1160	CS	440
1	100	L-Allis	1770	RX.T.E.F.C.	440
1	150	G.E.	720	KT-562	440
2	250	G.E.	1790	K.-T.E.F.C.	2300

MOTOR GENERATOR SETS

Qu	K.W.	Make	Speed	Volts DC	Volts AC
1	10	G.E.	1800	125	220/440 V.
1	30	G.E.	1800	125	220/440 V.
3	60	E.M.	1200	125	220 v. Syn.
1	75	G.E.	1800	250	480 v. S.C.
1	100	Cr. Wh.	1200	250	480 V. Syn.
1	150	CR. Wh.	600	125	220/440
1	300	G.E.	1200	250	2300/4160Y S.R.
1	1000	West.	720	600	2300/4160Y

D.C. 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
1	30	G.E.	1650/1800	CDM 85
3	30	C.W.	700	CM
1	35	G.E.	860	RC
2	75	C.W.	900	WP
1	125	G.E.	1700	RC
2	150	C.W.	900	WP

A.C. HOIST MOTORS

Qu	HP	Make	Type	Speed	Volts
1	35	G.E.	MTC	505	440
2	399	G.E.	ITC-5017	600	440

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138 CFM	100 PSI	7x7	Ingersoll	ESI
234 CFM	100 PSI	9x8x9	Chicago St.	(new)
268 CFM	500 PSI	10-4½x10	Ingersoll	XOB
343 CFM	500 PSI	11-5x13	Worth.	(new frame)
464 CFM	100 PSI	12x11	Gardner	RX
478 CFM	100 PSI	11½x7x7	Worthington	YB2
552 CFM	100 PSI	13-8x12	Ingersoll	XRB
593 CFM	100 PSI	13½-8x8	Ingersoll	XRE2
676 CFM	100 PSI	15-9¼x12	Ingersoll	XRB
640 CFM	100 PSI	16-10x10	Pennsylvania	DE2
877 CFM	100 PSI	17-10½x14	Ingersoll	XRB
1665 CFM	42 PSI	16-16x10	Ingersoll	XRE1
1723 CFM	110 PSI	140 lbs. st	Ingersoll	XPV

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Telephone UNion 5-4848

NEW 25 CYCLE — MOTORS AT LONG DISCOUNTS

Qu.	HP	Make	Phase	Volts	Brg.	Frame	RPM
16	¾	Was.	1	110/220	SL	65X	1425
9	½	Was.	1	110/220	SL	65X	1425
10	½	Whse.	3	220/440	SL	145	1425
8	¾	Whse.	3	220/440	SL	186	1425
3	¾	Whse.	3	550	BB	186	1425
3	¾	G.E.	3	220	SL	77	1425
3	1	L.A.splash	3	550	BB	224	1450
5	1	Whse.	3	220/440	SL	FX224	1450
7	2	L.A.splash	3	550	BB	FX225	1450
5	3	L.A.splash	3	550	BB	FX254	1450
1	5	L.A.splash	3	550	BB	FX284	1450
3	10	L.A. XP	3	220/440		JEX364	1450
1	15	G.E. used	3	220/440		365	1450
1	25	Rel. XP	3	220/440		405	1450

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6—500 KVA, Westinghouse, OISC, 2300 volt primary, 460/230 volt secondary, 1 phase, 60 cycle.

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1—720 HP Fairbanks Morse Model 33, 5 cyl. 257 RPM, 580 KVA F-M 3/60/2400 V generator.

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1—400 HP Superior 4 cyl. 400 RPM Model VDSE, 250 KW, 3/60/2400 V.

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1000 KW G.E. Cond. Extr. 3/60/480 V 3600 RPM 225 PSIG 20# extr.

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GUARANTEED REBUILT POWER EQUIPMENT

SLIP RING MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2300 Volts or Higher)

H.P.	MAKE	TYPE	SPEED
2000	*G.E.	MT	600
1500	*Westg.	CW	600
1200	*Al-Ch	ANT	1800
1000	*Westg.	CW	450
700	*Al-Ch	ANY	720
600	*G.E.	MT	450
500	Westg.	CW	600
500	Westg.	CW	350
300	G.E.	IM-17B	1800
250	*G.E.	I-M	450
200	Westg.	CW	900
200	G.E.	IM	600
200	Westg.	CW	514
200	Westg.	*CW-950A	514
150	Cr-Wh	50-R	1800
150	G.E.	MT-549	1800
150	*Wagner	RS-131	900
150	Westg.	CW	450
125	G.E.	IM-15A	600
100	G.E.	IM-13A	1800
100	G.E.	MTC-5546	900
100	G.E.	I-M	720
100	G.E.	IM	600
100	G.E.	IM-15A	450
75	G.E.	MT-347	1200
75	G.E.	IM	1200
75	Al-Ch	ARY-223C	1200
75	G.E.	MT-356	900
75	Al-Ch	ANY-26F	900
75	Al-Ch	ARY	720
75	G.E.	IM	600
60	Al-Ch	ARY	1200
60	G.E.	MT-546	1200
60	G.E.	*MT-536	1200
60	*Westg.	CW-762C	900
50	*Al-Ch	ARY-220-BS	1800

SLIP RING MOTORS

Crane & Hoist Service
3 Phase, 60 Cycle, 220 or 440 Volts

H.P.	MAKE	TYPE	SPEED
80	G.E.	MTC-5552	600
75	Westg.	CI-756A	600
50	Westg.	MW-334	600
50	G.E.	HIC-TENV	600
35	G.E.	MTC-5536	600
20	Westg.	CI	1200
11	Westg.	CI-E464	900
10	P & H	BW-6	1800
5	P & H	BW-6	1200
5	N. West.	WRC	1200
3	G.E.	MTC-5944	900

PUNCH PRESS MOTORS

NEW—3/60/220-440 volt
High Torque—Hi Slip

H.P.	MAKE	TYPE	SPEED
75	Fr. Morse	QFZK	1065
60	Westg.	CS-752C	1060
40	Reliance	AA-B-505	1835
30	L-Allis	CK-445	1080
30	Wagner	RP-444	1080
25	Reliance	AA-C-504	1100

PLATERS

AMPS	MAKE	VOLTS
7500/3750	El. Prod.	6/12-220/440
2000/1000	Chandy.	6/12-220/440
1500/750	Chandy.	12/24-220/440
1500/750	Chandy.	6/12-220/440
1000/500	Chandy.	12/24-220/440

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2300 Volts or Higher)

H.P.	MAKE	TYPE	SPEED
1250	*Al-Ch	ANX	3600
1200	*Al-Ch	ARW	1200
750	*Westg.	CS	900
500	*Al-Ch	ARW	3600
500	*G.E.	KT5698	900
500	G.E.	KT-424	450
400	G.E.	KT-424	720
250	Westg.	CS-Tefc	1800
250	G.E.	KT-559	1800
250	*L-Allis	OEX-148	720
250	*G.E.	IK	600
250	G.E.	IK-17A	600
250	Westg.	CS-14	514
200	*G.E.	KT-549Y	3600
200	*G.E.	IK-13B	1800
200	G.E.	KT-564	900
200	Al-Ch	ARWWT	600
150	G.E.	IE-13B	1200
150	*Al-Ch	AN-30F	1200
150	G.E.	IK	900
150	*Westg.	CS	600
125	*Westg.	CS-771 Sppf	1800
125	*Al-Ch	AR	1800
125	Al-Ch	AR-226 CS	1800
125	*Reliance	AA 6085	900
100	Westg.	CS 507S TEFC	3600
100	*Westg.	CS	1800
100	*G.E.	FT-542Z	1800
100	G.E.	FTRP-543	1800
100	*Westg.	CS-760D	1200
100	G.E.	KT-553	1200
100	G.E.	IK	1200
100	Al-Ch	AW-230	1200
75	Al-Ch	KF-445S	3600
75	G.E.	KF-445Z	3600

D. C. MOTORS

H.P.	MAKE	TYPE	SPEED
250	Westg.	SK-220	450/600
200	Westg.	SK-201	650
200	Cr. Wh.	CM	560
175	G.E.	ELC	750
100	G.E.	MPC	400/800
100	G.E.	RC-34	2500
100	G.E.	RC-19	575
100/150	G.E.	MCF	380/1000
50	Cr. Wh.	CMC	700/1100
50	G.E.	DLC-204	650
35	Westg.	SK-150	350/1000
30	Cr. Wh.	CCM-504	450
30/40	G.E.	CD-115	500/1500
25	G.E.	RC-32	800
25	Westg.	SK-133	575
20/25	Westg.	SK-151L	250/1000
20	Star	SB-10	1750
15	Westg.	SK-103	400/1600

M.G. SETS

K.W.	MAKE	A.C.	D.C.
1250	Westg.	6600/4160	600
1000	G.E.	12,000	600
500	Westg.	2300	275
300	Westg.	2300/440	250
400	A.C.	2300	120/240
200	G.E.	2300	250/275
200	Westg.	2300/4000	250/275
200	Ridgeway	2300	250
170	G.E.	220	125
150	G.E.	2300	125/250
150	A.C.	2300	275
150	Westg.	2300	125/250
150	G.E.	440	275
125	Cr.Wh.	4160	125
100	G.E.	2300	250
100	Al-Ch	2300	250
100	El.Mch.	440	125

CHICAGO *Electric Co.*

1320 WEST CERMAK RD, CHICAGO 8, ILL.

BOILER FEED PUMPS

STEAM TURBINE DRIVEN

GPM	TFH	Stage	Mfg.
450	892	4	Worth. (2)
500	850	4	Worth.
200	1375	6	Ingersoll R. (2)
200	850	2	Weinman (2)
190	1320	4	De Laval
750	725	4	Worth. (2)

MOTOR DRIVEN

GPM	TFH	Stage	Mfg.
740	2250	3	Worth.
700	1550	6	Worth.
675	1100	5	LeCourtenay
500	1050	5	Worth. (3)
100	1150	5	Gould

UNDERWRITERS FIRE PUMP

GPM	TFH	Stage	Mfg.
1500	231	1 (motor driven)	Fairbanks
750	231	(gas. driven)	Allis Chal. (2)

MOTOR DRIVEN SAND PUMPS

American Manganese 10"
Allen-Shaffer-Hoff 14"

NASH HYTOR COMPRESSORS

(4) size #2, 850 R.P.M., 10# pressure, 240 C.F.M.; 860 R.P.M., 180 C.F.M., when used as a Vacuum Pump.

2—2800 Gal. cap. 100# steam press, hot water storage heaters, mfg. by Quaker City Iron Works. Good shape.

This is only a partial listing of pumps carried in stock. We have hundreds of other pumps, compressors, and power equipment. Don't ask us what we have, write and tell us what you want.

PHILADELPHIA TRANSFORMER CO.
Box 566 **Dalton, Pa.**

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
800	2300	Whse.	900
500	2200	G.E.	450
450	440	Whse.	514
400	4000/2300	Whse.	450
400(2)	2300	G.E.	900
300	2200/440	G.E.	720
300	440	G.E. (hoist)	600
300	440	Whse.	3600
250	2300/440	G.E.	1200
250	440/220	Whse.	600
250	550/440	G.E.	1200
225	4000/2300	G.E. (hoist)	600
200	440/220	Whse.	514
150(2)	440/220	G.E.	720
150	2200/440	G.E.	600
125	550/440	G.E.	1200
125	2200	G.E.	600

SYNCHRONOUS MOTORS 3-Ph 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
250	2200/440	G.E.	TS	720
250	440/220	Whse.	HR	277
250	440/220	G.E.	ATI	600
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G.E.	FT	3600
500	2200/4000	Elliot	SC	1800
400	2300/4000	Whse.	CS	720
400	2300/4000	G.E.	K	1800
350	440	G.E.	KT	1200
300	2300/4000	L. Allis	FS	1800
250	2300	Whse.	CS	900
250	2300	G.E.	K	900
225(2)	2200/440	G.E.	KT	1200
200	440/220	G.E.	KT	1800
200	2200/440	G.E.	JK	600
200	2200	G.E.	KT	1800
150	2200	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G.E.	KT	720
150	2200/440		KT	600

A. C. GENERATORS

1—320 kva, 660 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 2200 V., Whse.
1—225 kva 60 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm 2200/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-23, 600 amp., 15,000 V. G.E.
1—400 Amp., Condit, 3P, 25 KV outdoor
1—400 Amp., R. Smith, 3P, 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	2870
150	230	El. Dyn.	B/brg.	600
150	230	Whse.	SK	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
240	G.E.	4000/2300	Syn.	250
175	G.E.	220/440	Syn.	250
150	Whse.	440/220	Sq. Ca.	275
125	G.E.	4000/440	Syn.	125
125	G.E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—1000 kva, Whse., 13,800—2300 V., 3 ph., New
1—600 kva, Standard, 13,800—2300 V., 3 ph.
3—333 kva, G.E., 23000/11500—2300 V.
3—333 kva, Mol. 13,800—2300 V.
3—333 kva, G.E., 2400—480 V.
2—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—200 kva, G.E., 2300—575 V.
3—100 kva, Al. Ch., 2400—480/240 V.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

FOR SALE
18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

1—2500-KVA., WEST., 400#, 750° FTT., 28" VACUUM, GENERATOR, 3/60/2300-V.

Complete in every respect

1—1875-KVA., G.E., 440#, 750°FTT, 28" VACUUM, 3/60/2300-V.

Excellent Condition and Complete Both Priced Right.

CHARLES WEAVER
19701 James Couzens Highway **Detroit 35, Michigan**

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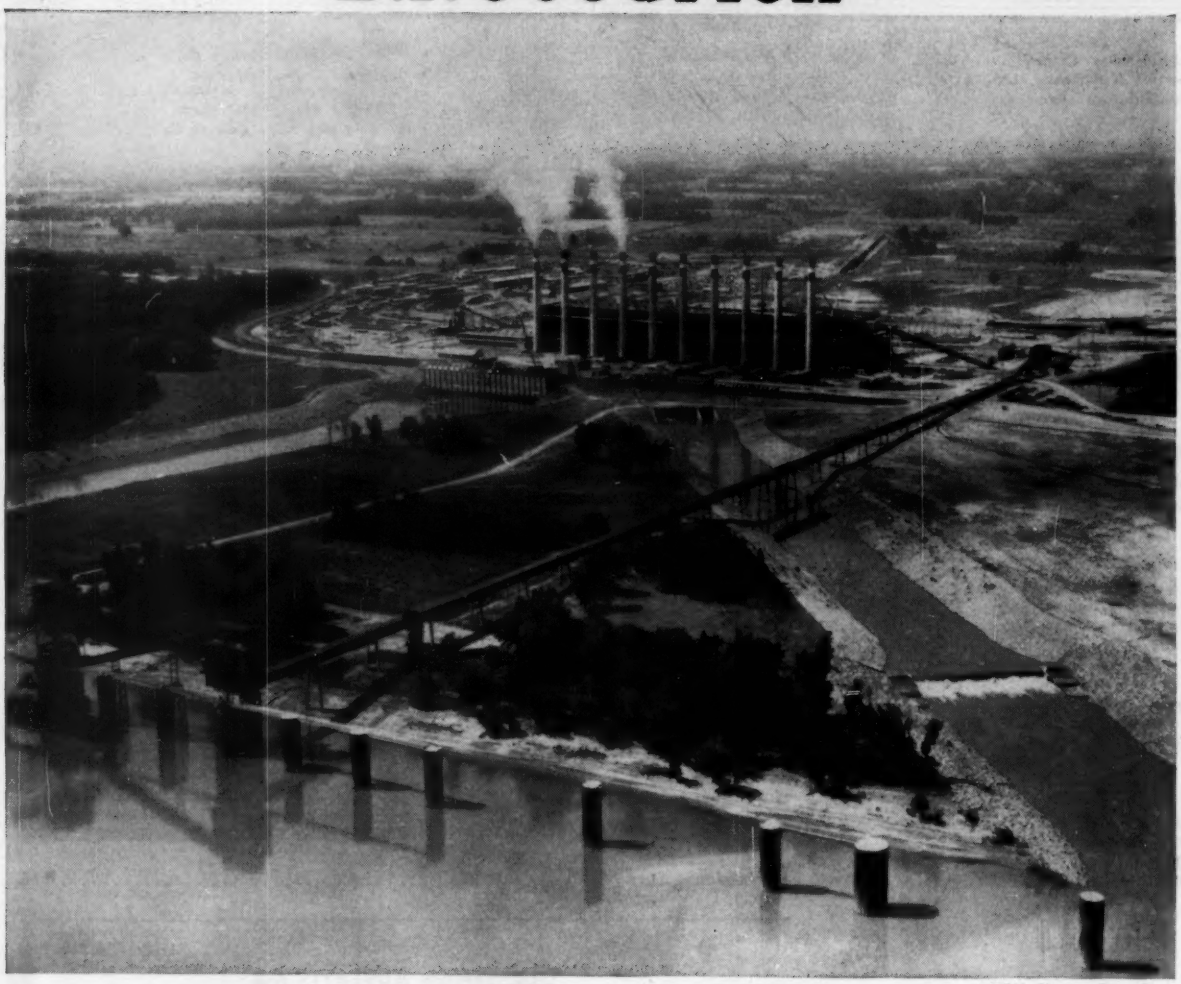
B.F.Goodrich



TVA's Shawnee Steam Plant

How to burn 600 tons of coal in one hour

A typical example of B. F. Goodrich improvement in rubber

THIS is one of the nation's biggest power plants. Coal that goes into it could furnish electric power for a city the size of Detroit. There's a network of nearly three miles of B. F. Goodrich conveyor belts running in four different directions. One goes over towers 50 feet high, over a road and a river channel; others tunnel underground. They carry 14,000 tons a day into the plant.

One belt half a mile long, running from the river into the plant, would once have been a terrific problem. But B. F. Goodrich had made these big systems practical by developing the cord belt. Cords running lengthwise, buried in the rubber, add so much strength that a single belt can travel distances once considered impossible. It's flexible too, and stands crashing blows from heavy lumps or sharp edges that would gouge or break many ordinary belts.

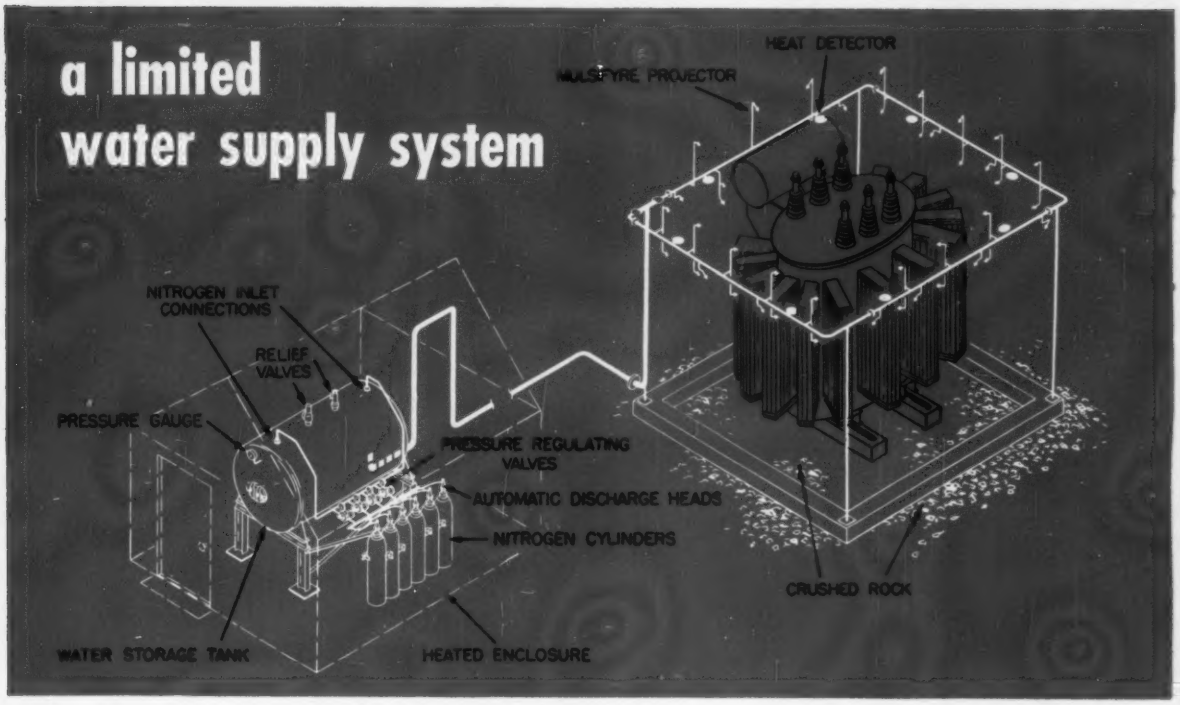
All of the other belts have other B. F. Goodrich improvements too, brought by better manufacturing methods—such as making belts under uniform tension, so that all fibers work together; seamless plies to avoid weak spots; cushioned edges for longer wear; patented layers called "breakers" to stand hard blows; mildew treatment to protect fabric. All these improvements and many others help cut costs through better performance.

Call your B. F. Goodrich distributor for more information about any kind of belting—or hose or other B. F. Goodrich rubber products. *B. F. Goodrich Industrial Products Co., Dept. M-713, Akron 18, Ohio.*

B.F.Goodrich

INDUSTRIAL PRODUCTS

NOW!
Grinnell SELF-CONTAINED Mulsifyre Protection

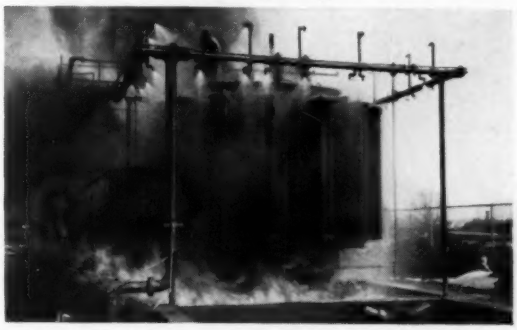


You need no longer be without water spray protection simply because your hazard is distant from city water mains. Grinnell's new *Self-Contained* Mulsifyre System provides automatic detection and prompt water spray protection in extinguishing fires while still small, and in preventing their spread with possibly serious damage.

Water spray protection, of course, presupposes water under pressure. Grinnell's *Self-Contained* System successfully achieves this through the use of nitrogen gas, stored in cylinders under high pressure, which drives the water from the storage tank at spray-forming velocities. As with all Grinnell Fire Protection Systems, the component parts of the Self-Contained Mulsifyre System are fully listed by Underwriters' Laboratories and meet specifications covered in NBFU Standards 13 and 15.

Your particular hazard will be thoroughly analyzed by the Grinnell Fire Protection Division, which introduced water spray protection in America — and has the widest possible background experience in its use. Full consideration will be given to the property to be protected, as well as to all other adjacent exposure hazards.

Let a Grinnell Fire Protection Engineer tell you more about this system. Grinnell Company, Inc., 278 West Exchange Street, Providence, Rhode Island. Branch offices in principal cities.



Grinnell *Self-Contained* Mulsifyre System successfully operating to extinguish fire under test conditions

GRINNELL *Mulsifyre*

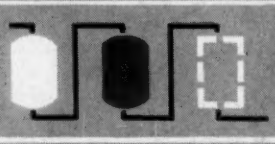
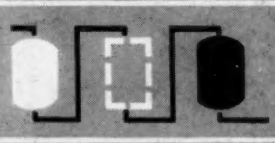
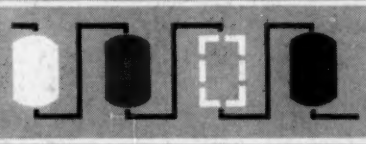
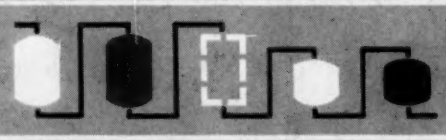
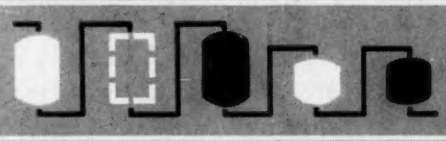
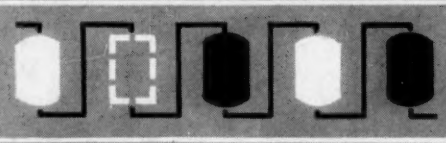
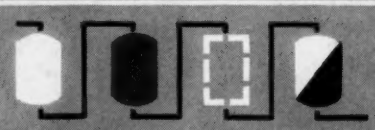
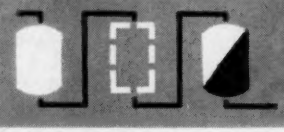
EMULSION EXTINGUISHMENT OF OIL FIRES

9 ways to demineralize water

(BY ION EXCHANGE)

KEY:

- **Hydrogen Cation Unit** — Removes metallic cations such as calcium, magnesium, sodium. Regenerated with sodium for simple water softening.
- **Weakly Basic Anion Unit** — Removes strongly ionized acids such as sulfuric, hydrochloric, nitric.
- **Strongly Basic Anion Unit** — Removes strongly ionized acids, also weakly ionized acids such as silicic and carbonic.
- **Mixed Bed Unit** — Contains both Hydrogen Cation and Strongly Basic Anion Exchangers, intimately mixed.
- **Degasifier** — Optional. Reduces load on Strongly Basic Anion Exchanger by removing free CO_2 brought in by raw water or developed in cation unit.

A	 Effluent Conductivity—10 to 20 micromhos (no silica reduction)	Uses low-cost anion exchanger and anion regenerant (soda ash). Typical use—removing soluble salts from water for ceramic mixes and slips or from rinse waters used before painting, mirror silvering, etc.
B	 Effluent Conductivity—same as A. Silica content—0.02 to 0.18 ppm.	Used for treating feedwater for boilers in general range of 600 to 1400 psi. Also (without degasifier) for removing impurities from plating baths and recovering chromate from plating rinses.
C	 Same effluent as B.	For raw water with high sulfate and chloride content. Low-cost Weakly Basic Anion Exchanger removes major portion of electrolyte load. Countercurrent regeneration of anion units reduces operating costs.
D	 Effluent Conductivity—3 to 5 micromhos. Silica same as B.	For same type of raw water as C. Countercurrent regeneration of both cation and anion units cuts operation costs.
E	 Effluent Conductivity—1 to 5 micromhos. Silica same as B.	For waters where alkalinity is a major part of the anion content. Polishing units require infrequent regeneration. Produces, at low cost, low-solids feedwater suitable for high pressure boilers (over 1400 psi).
F	 Same effluent as E.	High flexibility of operation. Can operate in parallel for peak flows. Can maintain service flow during regeneration of either pair of units.
G	Effluent Conductivity—less than 1 micromho. Silica same as B.	Produces effluent of extremely high quality. Suitable for "super critical" pressure boilers and atomic reactors. (Initial and operating costs are usually higher than for separate anion and cation units.)
H	 Same effluent as G.	For raw water with high sulfate and chloride content. Two-step demineralizer reduces load on Mixed Bed unit, cuts operating cost. (Strongly Basic Anion Exchanger is used in place of Weakly Basic where raw water has high silica and alkalinity.)
I	 Same effluent as G.	Recommended where alkalinity of raw water is high. Cation unit and Degasifier reduce load on Mixed Bed unit, cut operating costs.

All of the above systems, with equipment and resins made by Permutit, are in commercial use. Other combinations are possible—also use of special ion exchangers such as PERMUTIT SK for separating uranium oxide from other metallic oxides in ore.

Most of these systems (C and higher) are used almost exclusively for demineralizing feedwater for high-pressure boilers . . . but the list of possible applications in other fields is growing.

If you have a problem ion exchange might solve, we'll be glad to study it with you and bring you the benefits of this experience. Address: The Permutit Company, Dept. P-8, 330 West 42nd St., New York 36, N. Y.

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